

THE AUSTRALIAN GENUS *GUNNIOPSIS* PAX (AIZOACEAE)

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Abstract

Gunniopsis, which includes all Australian species previously included in *Aizoon* L. and *Neogunnia* Pax & Hoffm., is revised. Fourteen species are recognised and *G. calcarea*, *G. calva*, *G. divisa*, *G. papillata*, *G. propinqua*, *G. rubra* and *G. tenuifolia* are described as new. Two new combinations, *G. kochii* and *G. septifraga* are made. All species are illustrated and distribution maps and ecological data are provided.

Gunniopsis is compared with *Aizoon* L. and *Aizoanthemum* Dinter ex Friedr., two African genera with which *Gunniopsis* has previously been compared or considered synonymous. Pollen, capsule and seed characters are discussed and illustrated.

The majority of *Gunniopsis* species appear to be protandrous outcrossers, while a few are autogamous.

Introduction

The Australian species which have been previously referred to the genera *Aizoon* L., *Gunniopsis* Pax, *Gunnia* F. Muell. and *Neogunnia* Pax & Hoffmann are small succulent shrubs or herbs which are widespread throughout the eremaeic zones of Western and South Australia with a few species extending into the adjacent portions of the Northern Territory, Queensland and New South Wales.

With the exception of the shrubby *Gunniopsis quadrifida* which is very widespread and an important component of succulent shrublands in many areas, especially on saline soils in salt lake systems, most of the species have been poorly understood taxonomically. Doubt over the exact number of species found in Western Australia, for example, has resulted in considerable confusion. Gardner in his 1930 census listed six species under *Gunniopsis* and *Gunnia*, Blackall & Grieve (1954) included four under *Gunniopsis* and *Gunnia* while Green (1981) listed five under *Aizoon*, *Gunniopsis* and *Neogunnia*. *Aizoon kochii* Wagner, recognised by Toelken (1981) as a good species, was previously considered by Black (1924, 1948) to be merely a variant of *A. zygophylloides* F. Muell. and presumably Jacobs and Pickard (1981) accepted Black's view. Black's concept of *A. zygophylloides*, however, was largely based on an herbaceous species, *G. papillata*, which is vegetatively very similar to *G. kochii*. *Gunniopsis* (*Aizoon*) *zygophylloides* is a shrub restricted to rocky situations in central South Australia and the southern part of the Northern Territory. In addition to Black's misapplication of this name, West Australian authors had misapplied it to a previously undescribed perennial species restricted to the Nullarbor region (*G. calcarea*).

The apparent polymorphy of *A. zygophylloides* and the mixture of taxa from Western Australia indicated that a revision of the Australian species was long overdue. Furthermore, it was also considered essential that a re-evaluation of the generic limits of *Aizoon*, *Gunniopsis* and *Neogunnia* be carried out because of the uncertainty by various authors as to the status of the Australian species and whether *Aizoon* and *Gunniopsis* were congeneric or not.

History of the Australian Species

Aizoon was described by Linnaeus in 1753 to accommodate three species originating from the African region. Since this date the number of described species in this genus (sens. str.) has increased to about 20 (Dyer, 1975).

In 1859, Mueller described a number of new species from plant collections made by Hergolt on the Babbage Expedition to northern South Australia. Among the new species described were two collected at Stuart's Creek and named *Sesuvium quadrifidum* and *Gunnia septifraga*. Two years later, Mueller (1861) transferred the former species to *Aizoon* without comment, although previously he had noted (Mueller, 1859) that the ovary shape of *Sesuvium quadrifidum* was close to *Aizoon*. In 1871, Mueller described a second Australian species, *A. zygophylloides*, in the genus and three further species from Australia have been added by Wagner (1904) and Ewart (1908).

Pax (1894), in his treatment of the Aizoaceae in Pflanzenfamilien considered *Aizoon quadrifidum* to be distinct from the African species and placed it in a new genus *Gunniopsis*. He made, however, no mention of *A. zygophylloides* the only other Australian species known at that time. Diels (1904) followed Pax in recognising *Gunniopsis* and described a new species, *G. intermedia*, and transferred *A. zygophylloides* to this genus. This new combination was overlooked by all subsequent authors who have always attributed it to Maiden & Betche (1916). Black (1924), Gardner (1930) and Blackall & Grieve (1954) also followed Pax in recognising *Gunniopsis*.

Pax & Hoffman (1934) reverted to the use of *Aizoon* in the broad sense including *Gunniopsis* in the synonymy. They placed *Gunnia septifraga* and Bentham's (1867) *G. drummondii* in a new genus *Neogunnia* since Mueller's generic name *Gunnia* was illegitimate because the name had previously been used by Lindley in 1834. Black (1948) followed Pax & Hoffmann (1934) and placed the South Australian species of *Gunniopsis* in *Aizoon* and more recent authors have also recognised only *Aizoon*, e.g. Beard (1965), Toelken (1981), Jacobs & Pickard (1981). Green (1981) in his census of Western Australian plants used *Aizoon* for those species already described as, or transferred to that genus, but he also listed one species of *Gunniopsis* which had never been transferred.

Generic delimitation of *Aizoon*, *Aizoanthemum* and *Gunniopsis*

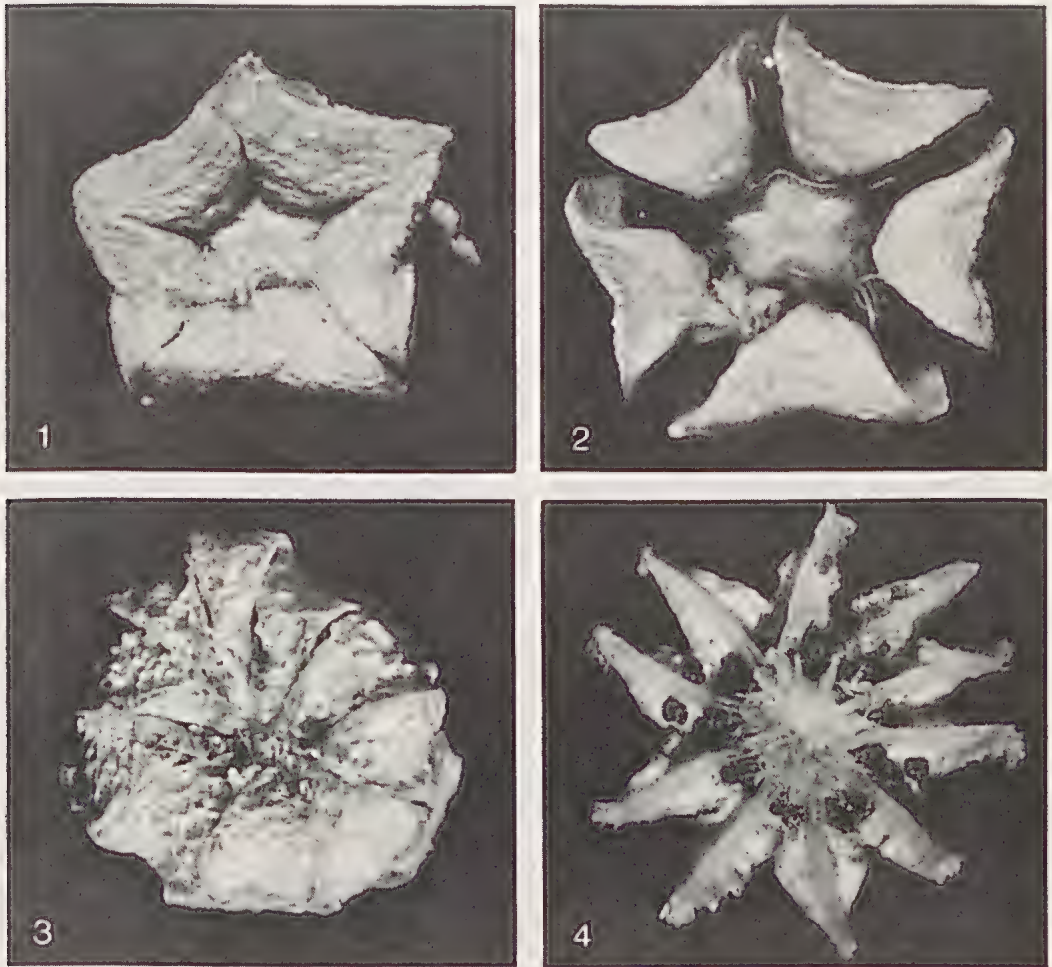
The superficial resemblance of *Aizoon*, *Aizoanthemum* and *Gunniopsis* have, to a large extent, contributed to the confusion between the genera. Adamson (1959), in his treatment of the South African species of *Aizoon*, subdivided the genus into three subgenera based on these three genera. He provided a key to the subgenera and basically distinguished them, as follows:-

1. Subgenus *Aizoon*—flowers 5-merous, carpels 5, valves not spreading, not hygroscopic.
2. Subgenus *Aizoanthemum*—flowers 5-merous, carpels 5, 7 or 10, fruit valves spreading, hygroscopic.
3. Subgenus *Gunniopsis*—flowers 4-merous, carpels 4, fruit with twice as many valves as carpels, hygroscopic.

His treatment of the subgenera appears to be superficial as he misinterpreted various features of the capsules of his subgenera *Aizoon* and *Gunniopsis*. Contrary to his view, the valves of *Aizoon* are hygroscopic, although they do not recurve like those in subgenus *Aizoanthemum*, but merely become displaced outwards separating the valves (Figs 1 & 2).

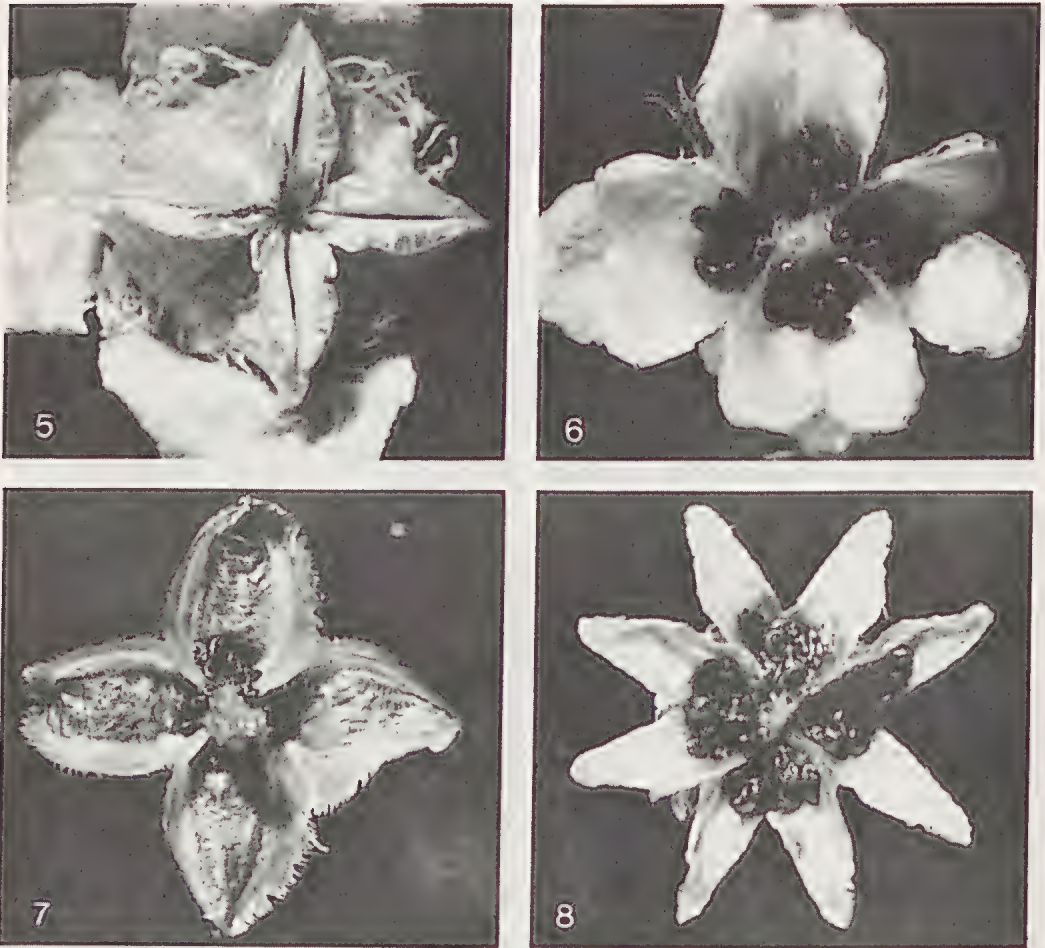
The capsule valve in most species of *Gunniopsis* splits, because of its shape, as the capsule opens for the first time with the result that each valve becomes shallowly or deeply lobed (see Fig. 44), and the capsule in the closed state may appear to have eight valves. Adamson does not indicate whether he studied any species from subgenus *Gunniopsis* but from his misinterpretation of the capsule valves it would seem unlikely. In his paper, Adamson cited Pax & Hoffmann as the authority for the subgenus *Gunniopsis* and although he gave a page reference for the combination, no such combination was published on that page or elsewhere in their treatment.

Adamson's subgeneric treatment of *Aizoon* has not been adopted by more recent authors working on South African plants. Both Friedrich (1970) and Dyer (1975) maintained *Aizoanthemum* as a distinct genus and after examining selected African material of *Aizoon* and *Aizoanthemum*, I would support this view.



Figs 1-4. 1, 2, *Aizoon glinoides*: closed and open capsule showing the outward displacement of the valves in the open position (Johnson 72, PRE). 3, 4 *Aizoanthemum dinteri*: closed and open capsule. Note the medial position of the expanding keel tissue on the opened valves. (Giess 8155, PRE).

Of the two African genera under discussion *Aizoanthemum* appears to be more closely allied to *Gunniopsis*. Both share the hygrochastic capsule type in which the valves when wetted, recurve through 180° or more, being opened by specialised bands of tissue called expanding keels. This capsule type is characteristic of *Mesembryanthemum* and allied genera which are often treated as a separate family (Mesembryanthemaceae). In *Aizoanthemum* the position of the expanding keels is median (Fig. 4) while in *Gunniopsis* it is marginal (Fig. 6-8). In addition to the capsule similarities, *Aizoanthemum* has prominently papillose leaves and branches as do a number of the ephemeral species of *Gunniopsis*, e.g. *G. kochii*, *G. papillata*. A summary of the more important characteristics of *Aizoon*, *Aizoanthemum* and *Gunniopsis* is given in Table 1.



Figs 5-8. 5, 6, *Gunniopsis intermedia*: closed and open capsule. Note the emarginate valve in the open capsule. (Chinnock 5406, AD); 7, *Gunniopsis divisa*: opened capsule showing the individual valves with prominent marginal expanding keels (Tyson 3, holotype MEL). 8, *Gunniopsis calva*: opened capsule showing valves almost split to their base. (Specht & Carrodus 110, AD).

Table 1. Distinguishing characters between *Aizoon*, *Aizoanthemum* and *Gunnioopsis*.

Character	Aizoon	Aizoanthemum	Gunnioopsis
Leaf arrangement	Alternate, very rarely opposite	Alternate, very rarely opposite	Opposite
Perianth segments	5	5	4
Stamen number	30 or more	30 or more	4-12, 30 or more
Stamen arrangement	2 or more whorls	2 or more whorls	2 or more whorls or in 4 groups alternate with the perianth segments
Capsule valve number	5	5 to 10	4 but sometimes appearing to be 8 due to bifid valves
Wetted valve movement	displaced outwardly	recurved through 180° or more	recurved through 180° or more
Position of expanding keel	median along valve	median along valve	marginal along valve
Seed sculpturing	ribbed	ribbed	variable but never ribbed

Previously, *Neogunnia* (= *Gunnia* F. Muell., non Lindl.), consisting of one species, *N. septifraga*, had always been treated as a distinct genus from the other Australian species which were then included in either *Aizoon* or *Gunnioopsis*. *Neogunnia* was distinguished by its four stamens which were arranged alternately with the perianth segments, while the known species of *Gunnioopsis* had 30 stamens or more. The latter are arranged either in four bundles each of which was positioned alternately with the perianth segments, similar to the stamens of *Neogunnia*, or in a series of whorls around the ovary. All other characters of *Neogunnia* agree with those of *Gunnioopsis* and one of the new species, *G. propinqua*, described here, has 1 to 3 stamens at each junction between the perianth segments. This clearly links *G. septifraga* with those species having numerous stamens in each bundle (e.g. *G. rodwayi*). It has been found that in some populations of *G. septifraga* (e.g. *Chinnock 5262*) some plants had flowers with eight stamens arranged in pairs. The reduction in stamen number, in my opinion, appears to be directly related to breeding systems and is not considered taxonomically significant at the generic level (see discussion under Floral Biology).

Notes on Morphology

(a) Plant Size

As in the case with many ephemeral plants the size attained by the individual is largely dependent upon the amount and regularity of precipitation received during the growing period. In favourable seasons ephemeral *Gunnioopsis* species like *G. kochii*, *G. papillata*, *G. intermedia* and *G. rodwayi* grow rapidly and plants may attain 50 cm in diameter, but in poor seasons the few plants which develop may only be a few centimetres across. Accordingly, only ranges of measurements are given except for where an extreme is well beyond the general range.

(b) Indumentum

The epidermal vestiture, where present, consists of either scales or uniseriate hairs. The uniseriate hairs present on *G. quadrifida* form a dense tomentum on the branches and leaves while in most species the trichomes are more scattered and usually succulent. On drying these hairs collapse to form flattened plates or become crisped along the margin. *G. calcarea* is the only species possessing scales.

(c) *Surface Features*

The epidermal cells on various parts of the plant, e.g. branches, leaves, perianth segments, ovary, are prominently raised in many species and give the surface its papillose appearance, but on drying it is sometimes difficult to discern this.

In many of the herbaceous species, which grow in very saline situations, salt crystallizes in the epidermal or subepidermal layers of the branches, leaves or on the outside surface of the perianth-segments. These crystals have only been noted in dried material and appear as isolated crystals which may or may not project through the surface or as irregular protuberances of crystal clusters, which have been termed pustules.

(d) *Leaves*

The leaves of all species are opposite, connate at the base and in some species form a short sheath along the node. The term leaf is used here to include true basal leaves and the leafy bracts subtending flowers, as in most cases they are indistinguishable. In *G. tenuifolia*, the leaves subtending the flowers are considerably smaller, but otherwise identical to vegetative leaves.

(e) *Plant colour*

Although a majority of species have been studied in the living state, a number, namely *G. divisa*, *G. calva*, *G. kochii*, *G. papillata* and *G. propinqua* have only been seen in the dried state or seen before this study was commenced and consequently the colour of vegetative structures had not been noted. It is considered likely that variation in colour, other than green, is found as it occurs in other herbaceous species.

(f) *Inflorescence*

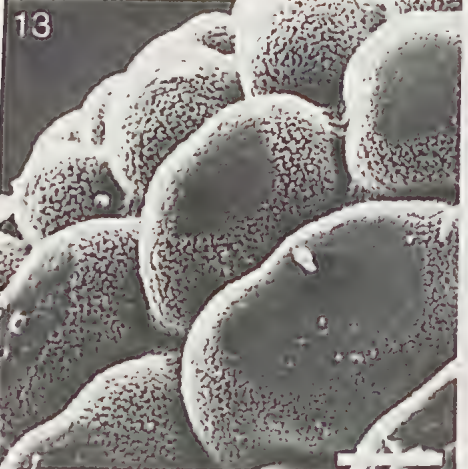
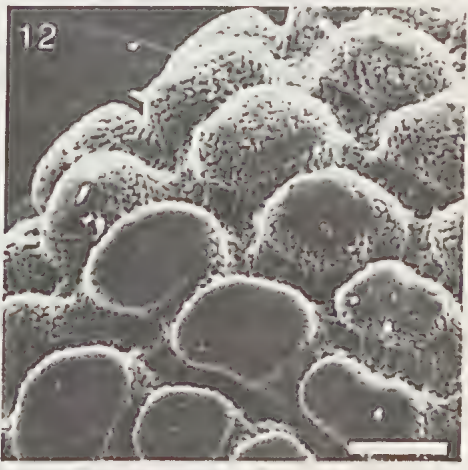
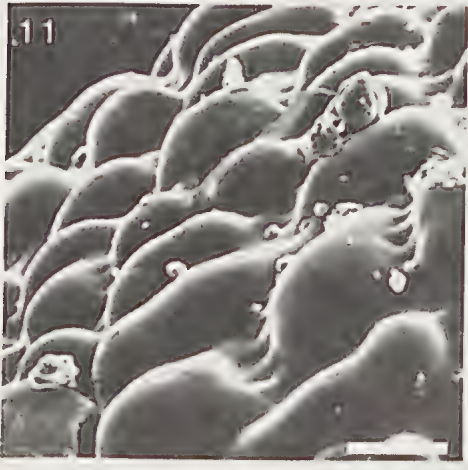
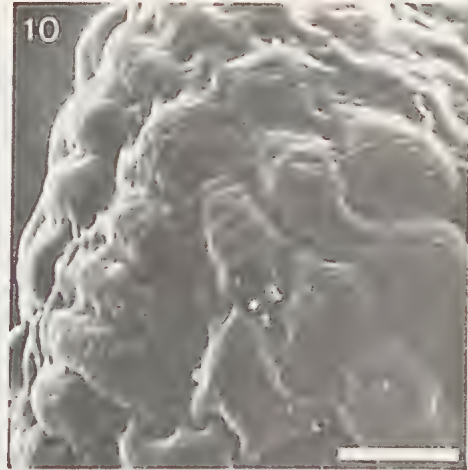
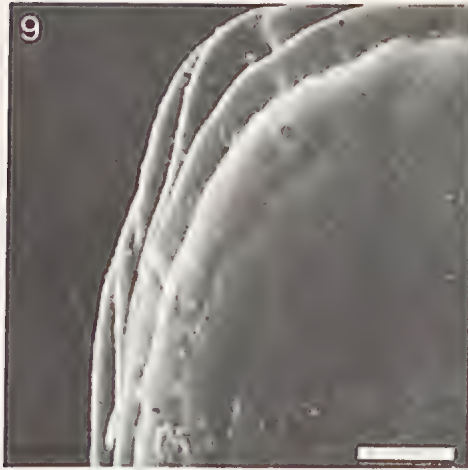
The inflorescence in *Gunniopsis* is usually a thyrsoid in well-developed plants but is often reduced in plants with less vigorous growth to a dichasium or a single flower (cf. Troll & Weberling, 1981).

The two large shrubby species, *G. quadrifida* and *G. tenuifolia* have distinct vegetative and floral phases of growth. This is most marked in the latter species, which has the inflorescence raised above the leaves. After the flowering period, new vegetative shoots arise below the inflorescences in both species and gradually overtop them. The whole plant, except for initial vegetative growth of seedlings of the shrubby species, *G. zygophylloides* and *G. calcarea*, and all the herbaceous ones, except for *G. divisa* and *G. glabra*, can be interpreted as inflorescence. Once the primary shoot is terminated by a flower, lateral branches develop in the axils of the subtending leafy bracts, which in turn are also terminated by flowers. This results in a pseudo-dichotomous branching pattern (e.g. Fig. 41, A & C).

The inflorescence of *G. glabra* is reduced to a single flower. In this case axillary buds remain dormant so that the flowering branch bears 5 or 6 pairs of leafy bracts before a flower terminates it. The inflorescence of *G. divisa* appears to be somewhat intermediate between the two conditions.

(g) *Perianth*

In all but two species, *G. rubra* and *G. divisa*, the perianth segments are fused together in the lower third or lower. The colour of the inside surface of the perianth segment, with two exceptions, is constant for a species. In *G. papillata* it varies from white to yellow and *G. propinqua* from white to pink.



Figs 9-14. Variation in sculpturing of the seed testa: 9, *G. rubra*; 10, *G. septifraga*; 11, *G. tenuifolia*; 12, *G. kochii*; 13, *G. calcarea*; 14, *G. divisa*. (Scale = 50 μ m.)

(h) *Seeds*

The shape of the seed and the cells of the testa were found to be very useful in distinguishing species of *Gunniopsis*, and within a species the ornamentation of the testa was relatively uniform. Variation in basic seed shape as seen in distal view is illustrated by *G. calva* (Fig. 44), *G. divisa* (Fig. 45) and *G. glabra* (Fig. 46). In side view the seed of all species is ovoid.

The descriptive terms used for the sculpturing of the testa follow Stearn (1973), although "colliculate" has been broadened to include the more elongate cell types as found, for example, in *G. divisa*.

The types of sculpturing of the testa of *Gunniopsis* varies considerably ranging from an almost smooth surface except for the sulcated outer edge (Fig. 9) to rugose (Fig. 10), colliculate (Figs 11-14), tuberculate (Figs 15-18) and granulate (Fig. 37G). The cells are often arranged in distinct rows, e.g. Figs 40K, 43H, 45H.

In contrast to *Gunniopsis* the seeds of *Aizoanthemum* (*A. dinteri*, *A. galenioides*, *A. membrum-connectens*) and *Aizoon* (*A. canariense*, *A. glinoides*, *A. sarmentosum*, *A. rigidum*), which I have examined are similar in size and shape to *Gunniopsis*, but differ in that the testa is ribbed (Fig. 20). In *G. rodwayi* tubercles along the outer edge of the testa sometimes partially coalesce and approach the ribbed condition found in the African genera, but the individual cells always remain distinct, e.g. Fig. 19.

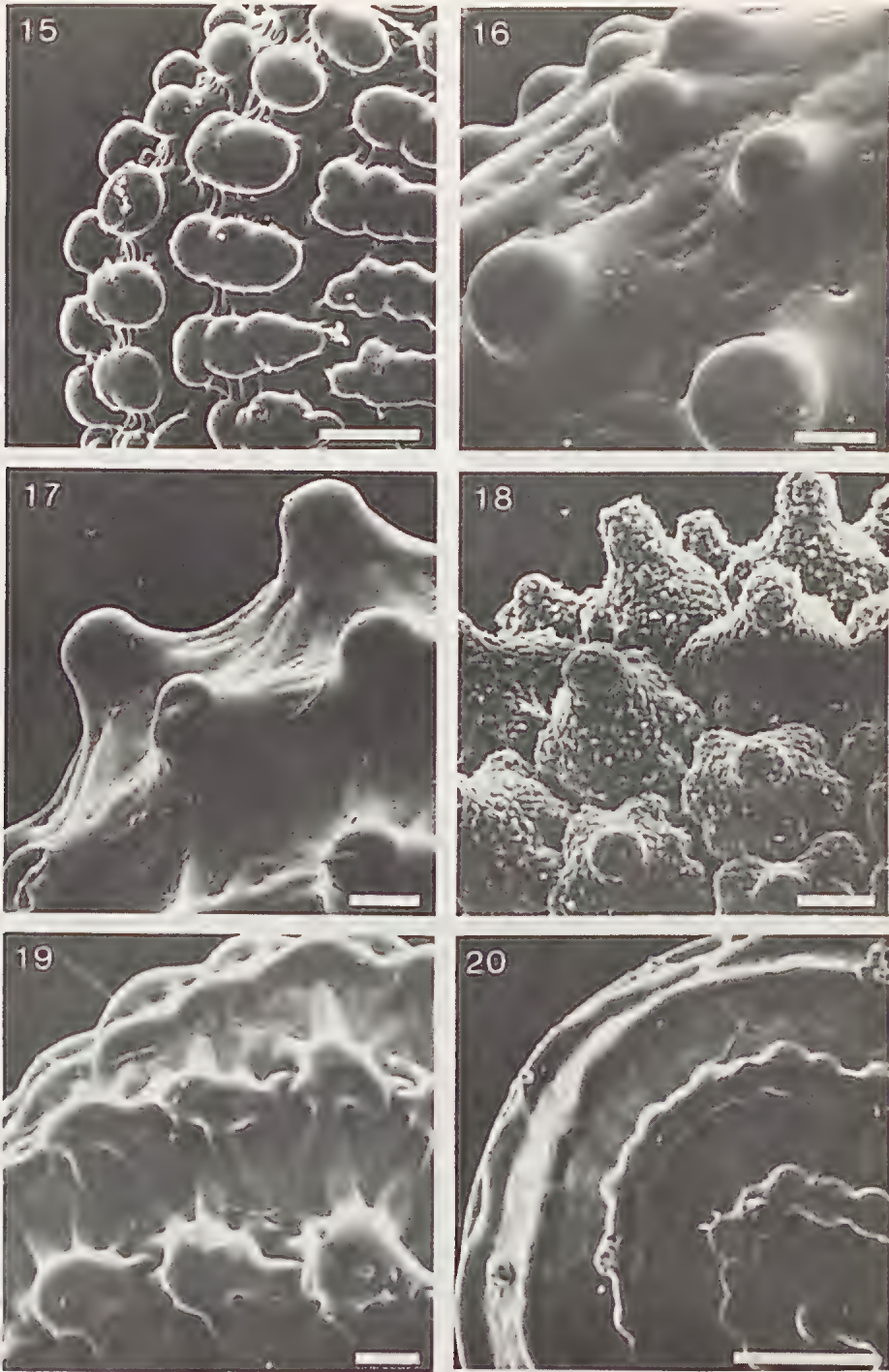
(i) *Palynology*

Erdtman (1952), who studied ten genera of the Aizoaceae, found the pollen grains to be fairly uniform throughout the family. Pollen grains of all species of *Gunniopsis* and selected species of *Aizoon* and *Aizoanthemum* were examined on an ETEC autoscanning SEM and an Olympus light microscope. In all three genera the pollen grains were found to be uniformly tricolpate, prolate-subprolate, and the sexine punctitegillate and prominently papillose (Figs 21-26). In *Gunniopsis* the pollen size range was 22.5-40 (-45) x 15-25 (-30) μm .

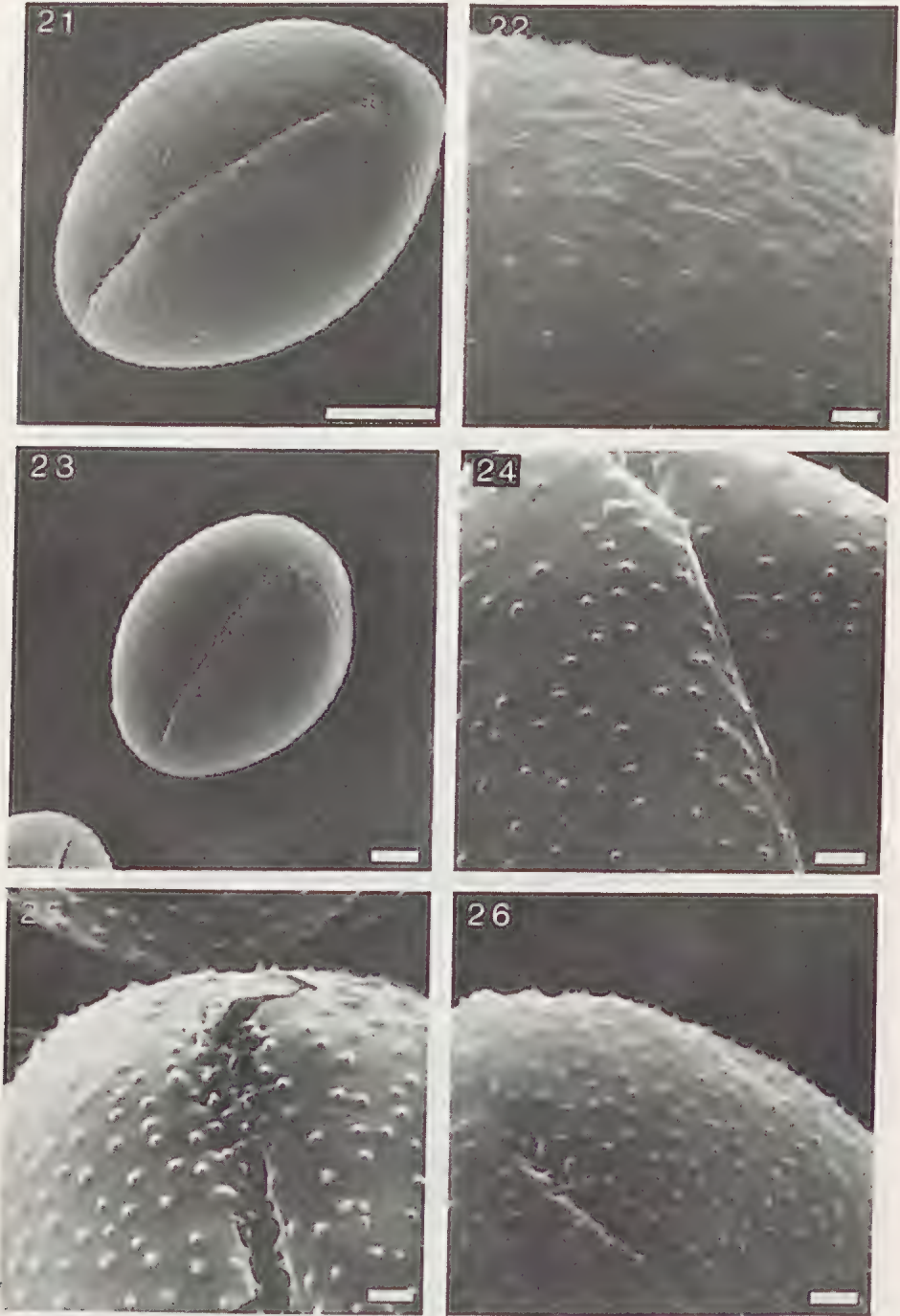
Floral Biology

While I was conducting taxonomic field studies on *Gunniopsis* populations in Western Australia in 1980-81, the opportunity was taken to examine flowers of the various species to try and determine the breeding systems and to note and observe any insects visiting them. In addition observations have been made on the flowers of three species in cultivation, and some information was also obtained from dried herbarium material. Unfortunately, neither the time nor opportunity allowed an examination of such aspects of the breeding systems as pollen viability and longevity, stigma receptivity or self incompatibility so that the information reported here can only be taken as a guide to the probable syndromes found within the genus.

The majority of species of *Gunniopsis* are protandrous while two, possibly three species appear to be autogamous. Pollination of protandrous species appears to be carried out by a variety of insects from the orders Lepidoptera, Hymenoptera, Diptera and to a lesser extent Coleoptera. Members of all these groups have been observed feeding on *G. quadrifida* and *G. rodwayi*, although the most common visitors were bees including various native species and the introduced honey bee (Fig. 28). At one locality even ants were swarming over plants of *G. quadrifida* and it would seem likely that pollination would occur under such circumstances, especially if the species is self-compatible.



Figs 15-20. Variation in sculpturing of the seed testa. 15, *G. papillata*; 16, *G. quadrifida*; 17, *G. glabra*; 18, *G. intermedia*; 19, *G. rodwayi*; 20, *Aizoanthemum dinteri*. (Scale = 50 μ m.)



Figs 21-26. Pollen morphology of *Gunniopsis*, *Aizoon* & *Aizoanthemum*; 21-22, *G. quadrifida* (Chinnock 5187, AD); 23-24, *G. septifraga* (Chinnock 5262, AD); 25, *Aizoon glinoides* (Maguire 759, PRE); 26, *Aizoanthemum galenoides* (Giess 2569, PRE). (Scale: Figs 21 & 23 = 10 μ m; figs 22, 24-26 = 1 μ m.)



Figs 27-28. Insects feeding on *Gunniopsis quadrifida*: 27, unidentified beetle; 28, *Apis mellifera*.

Observations were made on the flowers of plants of *G. calcarea* and *G. glabra* cultivated in Adelaide. The duration from when the flower first opens until stigma separation was found to differ considerably. It must be noted here that flowers of all the species observed open in the morning and close again each evening.

G. calcarea (Figs 29-31) has the stamens arranged in two whorls. When the flower opens (day 1) the anthers are all intact and either erect or curved over the centre of the flower. At this stage the stigmas have not fully developed and the four are erect and appressed together along the receptive surfaces. Late on day 1 and early on day 2 the anthers of the inner whorl are spreading and beginning to dehisce. The stigmas are also fully elongated and mature but still appressed together. On day 3 all the anthers have dehisced and reflexed back onto, and between, the perianth segments. The stigmas separate and rest on the ovary with the receptive surface fully exposed. The flower illustrated continued to open for another 5 days but did not open on day 9.

The above process took considerably longer in *G. glabra* (Figs 32-34). In this species which has up to 9 whorls of anthers, all anthers had dehisced only on day 8, and on day 9 the stigmas separated. The flower was still opening on day 22.

It was noted in both cultivated as well as plants in the field, that in the case of protandrous species the pollen was found to be shed shortly after the anthers had dehisced. As flowers of *Gunniopsis* close each evening, one cannot exclude the possibility that self pollination occurs, assuming that the species are self compatible. The fact, however, that most of the pollen from the anthers is lost before the stigmas separate seem to suggest that outcrossing is more likely to result.

In the non-protandrous species the styles spread and the anthers dehisce and deposit pollen on the apparently receptive surface before the flower opens. Consequently these species are thought to be autogamous. At least in *G. septifraga* I suspect cleistogamy to occur frequently. Rarely are there more than one or two flowers open on a plant at any one time, unlike protandrous species in which numerous flowers are open each day.



Figs 29-34. Development of protandrous flowers in two species of *Gunniopsis*. *G. calcareo* 29-31: 29, early day 2 outer anthers dehiscing; 30, late day 2 inner whorl of anthers start dehiscing, stigmas mature but erect and appressed; 31, late day 3 all anthers dehiscing and reflexed, stigmas spreading. *G. glabra* 32-34, day 4 outer whorls of anthers progressively dehiscing inner whorls still incurved over stigmas; 33, day 8 all anthers dehiscing and stigmas just separating; 34, day 13 stigmas spreading and very prominent, stamen remains shrivelled.

There would appear to be a correlation between floral characters, especially stamen number, and breeding systems. Protandrous species have large showy flowers which are pure white, yellowish-green, yellow or pink on the inside of the perianth segments. Stamens are numerous and either arranged in a series of whorls around the ovary (Fig. 35, A) or grouped in four bundles (Fig. 35, B). In contrast, autogamous species have small inconspicuous flowers often difficult to detect amongst the leaves and the stamens are reduced to 4 (Fig. 35, D).

The flower of *G. propinqua* (Fig. 35, C) appears to be intermediate between these two groups. These flowers, although small, are white or pink, raised above the leaves, and the number of stamens range from 4 to 12.

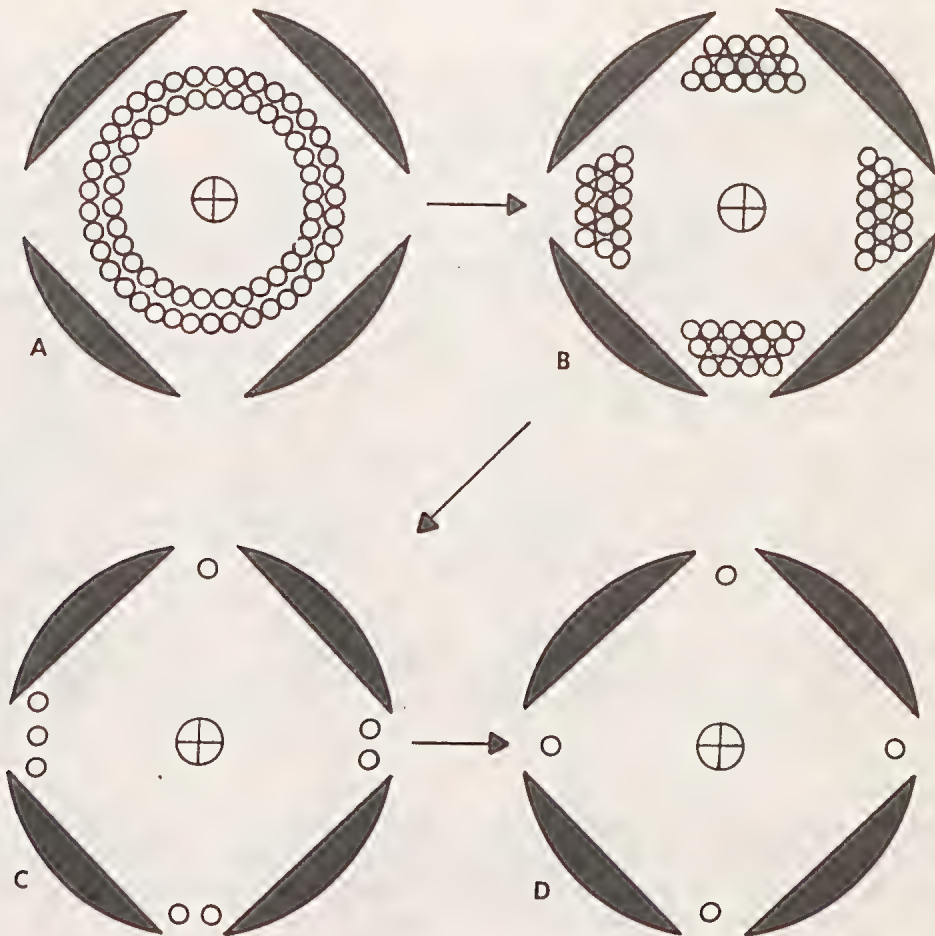


Fig. 35. Theoretical rearrangement and reduction of stamens in *Gunnioipsis* accompanied by a change from protandry (A-B) to autogamy (D, ?C). A, stamens in whorls (2-9) around the gynoecium, e.g. *G. zygophylloides*, *G. glabra*. B, stamens numerous, aggregated into 4 groups, *G. quadrifida*, *G. tenuifolia* and *G. rodwayi*. C-D, stamens in one whorl and aggregated into four bundles with 1-3 stamens in each bundle, e.g. *G. propinqua* (C) and *G. septifraga* (D).

Distribution and Relationships of the Species

Gunniopsis is widespread throughout the salt lake—clay pan systems of the Eremaean zone (Burbidge, 1960) south of latitude 20°S, the South-West Interzone and the Avon Botanical District (South-West Province) Western Australia (Beard, 1980).

Apart from two widespread species, *G. quadrifida* and *G. septifraga*, which extend throughout most of the range of the genus, the remaining species occur in three distinct zones (Map 1): Zone A, which contains six endemic species extends from the Eastern Goldfields and Lake Carnegie in Western Australia westwards to the coast; Zone B, contains one endemic species and extends along the Nullarbor Plain from Western Australia to South Australia; Zone C, containing five endemic species extends from northern Eyre Peninsula in South Australia north to the southern Northern Territory. One species, *G. papillata* also occurs in two small disjunct regions, one centred on Mt Isa and the other in the extreme north-west of New South Wales and south-west Queensland.

Species of Zone A

Five of the species restricted to this zone, namely *G. divisa*, *G. glabra*, *G. rodwayi*, *G. propinqua*, and *G. rubra* are more closely related to one another, or to *G. septifraga*, than to the species found in Zones B and C or *G. quadrifida*.

G. divisa, *G. glabra* and *G. rodwayi* are all closely allied sharing glabrous vegetative parts and similar structured leaves, but differ in the complexity of the inflorescence, the degree of dissection of the perianth segments, arrangement of the stamens and features of the seed. The similar shape and ornamentation of the seed and the basal fusion of the perianth segments in *G. glabra* and *G. rodwayi* suggest that these two species are more closely related to each other than to *G. divisa* which has seed with a shape and ornamentation suggesting a possible link with *G. kochii*. In addition, the perianth segments of *G. divisa* are free. The stamens of *G. rodwayi* are grouped in four bundles and it is considered that this feature links the species to the *G. septifraga* group.

G. propinqua and *G. rubra* are allied to *G. septifraga* sharing with this species a small stature, the leaf shape, reduced stamen number 4-12 (compared with more than 30 stamens in all other species) very small seeds and the apparent autogamous breeding system. The terete to oblong leaves and the arrangement of the stamens into four bundles of this group are features shared with the two shrubby species, *G. quadrifida* and *G. tenuifolia*.

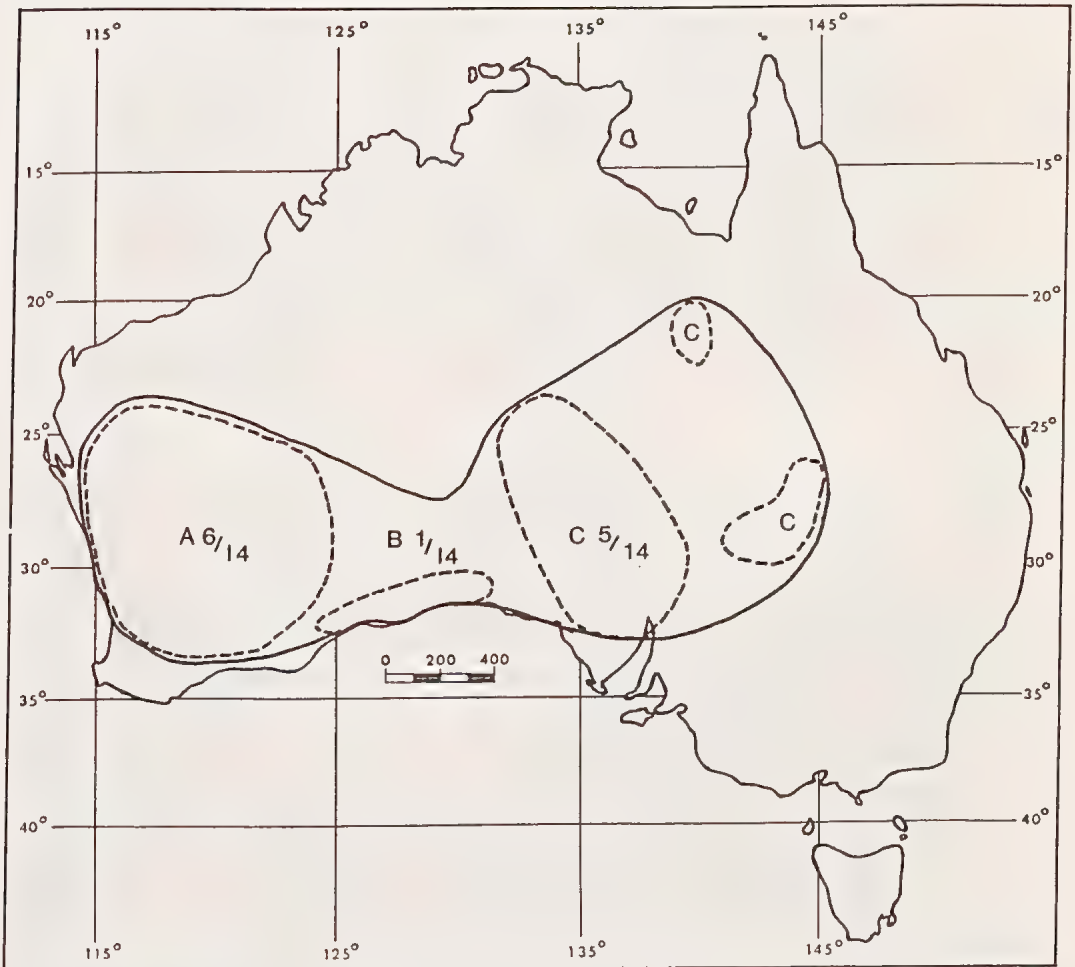
G. intermedia, the remaining species restricted to this zone, differs from the other endemics in having perianth segments coloured yellow inside, differently shaped leaves, and stamen filaments which have flattened bases. In these respects, *G. calva* would appear to be its closest relative.

Species of Zones B and C

The six species restricted to Zones B and C fall into three groups. Group 1 consists of *G. calcarea*, restricted to the Nullarbor Plain (Zone B), and *G. zygophylloides* extending throughout Zone C. Both are small shrubs with similar flowers, fruit and seed but differ in their type of indumentum and differently shaped leaves.

The second group consists of three annual species, *G. calva*, *G. papillata* and *G. kochii*. They share a similar habit and leaf shape but differ in the presence or absence of indumentum on the branches, the shape of the staminal filaments and the shape and ornamentation of the seed. The latter two species are very closely allied and difficult to distinguish unless seed is present or the colour of the inner surface of the perianth segment is known. Vegetatively the two are almost identical.

The third group, consisting of *G. tenuifolia*, is closely allied to *G. quadrifida*. These two shrubby species have similarly shaped leaves and stamens grouped in four bundles. They differ in the presence or absence of indumentum on the vegetative parts, the inflorescence, the colour of the inside surface of the perianth segments and the seed ornamentation.



Map 1. Distribution of *Gunniopsis* (solid line) showing the number of endemic species as a fraction of the number of species in the genus in Zones A-C (broken line).

GUNNIOPSIS Pax

Gunniopsis Pax in Engl. & Prantl., Nat. Pflanzenfam. 1st edn 3, 1b: 44 (1894); Diels, Bot. Jahrb. 35: 197 (1904); Black, Fl. S. Aust. ed. 1: 221 (1924); Gardner, Enum. Pl. Aust. Occid. 2: 42 (1930); Blackall & Grieve, West. Aust. Wildfls 1: 163 (1954).

Type species: *G. quadrifida* (F. Muell.) Pax

Aizoon sensu Benth., Fl. Aust. 3: 327 (1867); Bailey, Fl. Qd. 2: 706 (1900); Pax & Hoffm. in Engl. & Prantl, Nat. Pflanzenfam. 2nd edn 16C: 222 (1934) p.p.; Black, Fl. S. Aust. ed. 2: 341 (1948); Toelken in Jessop Fl. Cent. Aust. 35 (1981).

Gunnia F. Muell., Rep. Babb. Exp. 9 (1859); Benth., Fl. Aust. 3: 327 (1867); Gardner, Enum. Pl. Aust. Occid. 2: 42 (1930); Blackall & Grieve, West. Aust. Wildfls 1: 163 (1954), nom. illeg., non Lindl.

Neogunnia Pax & Hoffm. in Engl. & Prantl, Nat. Pflanzenfam. 2nd edn 16C: 225 (1934); Black, Fl. S. Aust. ed. 2: 340 (1948); Toelken in Jessop, Fl. Cent. Aust. 36 (1981); Jacobs & Pickard, Pl. N.S.W. 62 (1981); Cunningham et al., Pl. West. N.S.W. 295 (1981).

Annual or perennial, succulent herbs sometimes with a woody base to woody shrubs. *Leaves* at the base and on flowering branches opposite, exstipulate, sessile, connate. *Inflorescence* a thyrse composed of one or more dichasia, but because subtending bracts are leaf-like flowers often appear solitary and terminal. *Flowers* 4-merous. *Perianth* free or fused in the lower third or lower; segments valvate. *Stamens* in 1 to 9 whorls, 30 or more, or reduced to 4-12, evenly distributed around ovary or aggregated into four bundles alternate with perianth segments. *Pollen* 3-colpate, prolate to subprolate, sexine punctategillate, papillose. *Carpels* 4, fused; stigmas filiform, sessile. *Fruit* a hygrochastic capsule; valves 4, acute or splitting to varying degrees when capsule first opens and becoming emarginate or bifid; valves when wetted recurved through 180° or more by marginal expanding keel tissue; expanding keels entire or prominently serrate; chambers 4, seed numerous, placentation axile. *Seed* ovoid to almost circular, crustaceous, embryo curved, often almost surrounding the endosperm.

The 14 species are endemic to Australia and widespread throughout the drier parts of the continent.

Key to Species

1. Stamens 4-12 2
1. Stamens 30 or more 4
2. Leaves oblong to oblanceolate; seeds white but brown along the outer edge, smooth or rugose; plant green or yellow 12. *G. septifraga*
2. Leaves linear; seeds brown, smooth; plant green to red 3
3. Valves of capsule deeply bifid; seeds triangular in distal view, the cells arranged in 5 to 7 rows; perianth white to pink; plant green 14. *G. propinqua*
3. Valves of capsule undivided; seeds lenticular, furrowed along the distal edge; perianth green; plant turning red with age 13. *G. rubra*
4. Leaves linear, terete; stamens arranged in four bundles 5
4. Leaves dorsiventrally flattened, ovate, obovate to lanceolate or oblanceolate; stamens in a continuous ring, rarely in four bundles 6
5. Branches and leaves glabrous except for the ciliate leaf bases; perianth yellow-green . 2. *G. tenuifolia*
5. Branches and leaves clothed in a white to yellow tomentum; perianth white 1. *G. quadrifida*
6. Branches glabrous 7
6. Branches possessing hairs or scales 13
7. Flowering branches wiry, flowers solitary; plant perennial with a prominent taproot ... 10. *G. glabra*
7. Flowering branches fleshy, flowers numerous or rarely 2-3; plant annual, lacking a taproot 8

8. Perianth segments bright yellow.....9
 8. Perianth segments white or pink10
 9. Branches and leaves smooth, shiny; WA 5. *G. intermedia*
 9. Branches and leaves papillose, dull; SA, NT, Q, NSW 6. *G. papillata*
 10. Perianth pink; leaves and branches papillose..... 7. *G. kochii*
 10. Perianth white, leaves and branches smooth11
 11. Stamens arranged in four bundles11. *G. rodwayi*
 11. Stamens evenly distributed around the ovary12
 12. Flowering branches wiry; capsule valves undivided9. *G. divisa*
 12. Flowering branches fleshy; capsule valves deeply bifid..... 8. *G. calva*
 13. Branches and leaves with flattened appressed \pm circular scales4. *G. calcarea*
 13. Branches and leaves with long, flattened, or succulent hairs.....14
 14. Plant woody at least at the base; leaves ovate to oblanceolate 3. *G. zygophylloides*
 14. Plant herbaceous; leaves oblong to oblanceolate.....15
 15. Perianth segments pink; seeds laterally expanded into broad lobes 7. *G. kochii*
 15. Perianth segments white or yellow; seeds laterally flattened 6. *G. papillata*

1. **Gunnioopsis quadrifida** (F. Muell.) Pax in Engl. & Prantl. Nat. Pflanzenfam. 1st edn 3, 1b: 44 (1894); Black, Fl. S. Aust. ed. 1: 221 (1924); Gardner, Enum. Pl. Aust. Occid. 2: 42 (1930); Blackall & Grieve, West. Aust. Wildfls 1: 163 (1954).

Type: (*D. Hergolt s.n.*), Stuart's Creek, not located; neotype here designated: J.Z. Weber 5790, 10 km S of Stuart Creek Homestead, South Australia, 6.x.1978 (AD; isoneotypes: BRI, CANB, K, MEL, PERTH, PRE).

Sesuvium quadrifidum F. Muell., Rep. Babb. Exped. 9 (1859).

Aizoon quadrifidum (F. Muell.) F. Muell., Frag. 2: 148 (1861); Benth., Fl. Aust. 3: 327 (1867); Bailey, Qd Fl. 2: 707 (1901); Black, Fl. S. Aust. ed. 2: 341 (1948); Toelken in Jessop, Fl. Cent. Aust. 36 (1981); Cunningham et al. Pl. West. N.S.W. 291 (1982).

Typification

The specimen collected by Hergolt at Stuart Creek was not located at either MEL or K, the only two herbaria where collections from the Babbage Expedition are known to be housed. Bentham (1867) appears to have seen the type as he provides more information than that found in the protologue, ("Desert at Stuart's Creek, *Hergolt*"); however, the other specimen cited by Bentham could not be located at MEL either.

In selecting a neotype a modern collection has been chosen in preference to one of the specimens subsequently seen by Mueller as these are of poor quality. The neotype selected was collected very close to the type locality and fits Mueller's description of *Sesuvium quadrifidum* well.

Shrub 0.3-1 x 0.3-1 (-1.3) m, compact, rounded \pm divaricate with the branches, leaves and perianth segments (outside) covered with a yellow, grey or white scurfy tomentum. *Leaves* linear-terete, subterete in the lower part and flattened on the upper side, obtuse, (4-) 10-50 (-80) x 1.1-3 mm. *Flowers* pedicellate. *Perianth* fused basally, segments almost equal or two distinctly larger, ovate to triangular, apex acute or acuminate, 5.5-28 x 3.7-10.1 mm, outside surface white scurfy tomentose; inside surface white, prominently papillose. *Stamens* numerous, in 3 or more whorls, grouped into four bundles alternate with perianth segments; filaments terete, papillose; anthers smooth. *Ovary* ovoid, 4-ribbed, papillose. *Capsule* 4-ribbed, 4.5-8.5 x 5-9.5 mm; valves when opened deeply bifid so that the capsule closed appearing 8-valved. *Seed* 1.3-1.8 x 1.1-1.5 mm, ovoid, black, tuberculate. (Figs 16, 21, 22, 27, 28, 36. Map 2).



Fig. 36. *Gunniopsis quadrifida*. A, habit; B, enlargement of branch with leaves; C, longitudinal section through the flower to show the stamen bundles; D, lateral view of fruit; E, longitudinal section of capsule; F, opened capsule; G, lateral view of seed (based on Chinnock 5170).

Common on outwash plains, along drainage channels and on rises adjacent to salt and freshwater lakes where it often locally dominates or codominates with chenopodiaceous genera such as *Halosarcia*, *Atriplex* and *Maireana*. It occurs on a variety of sandy or clay loam soils, widespread throughout southern Western Australia and South Australia, but localised in the Northern Territory, western Queensland and western New South Wales.

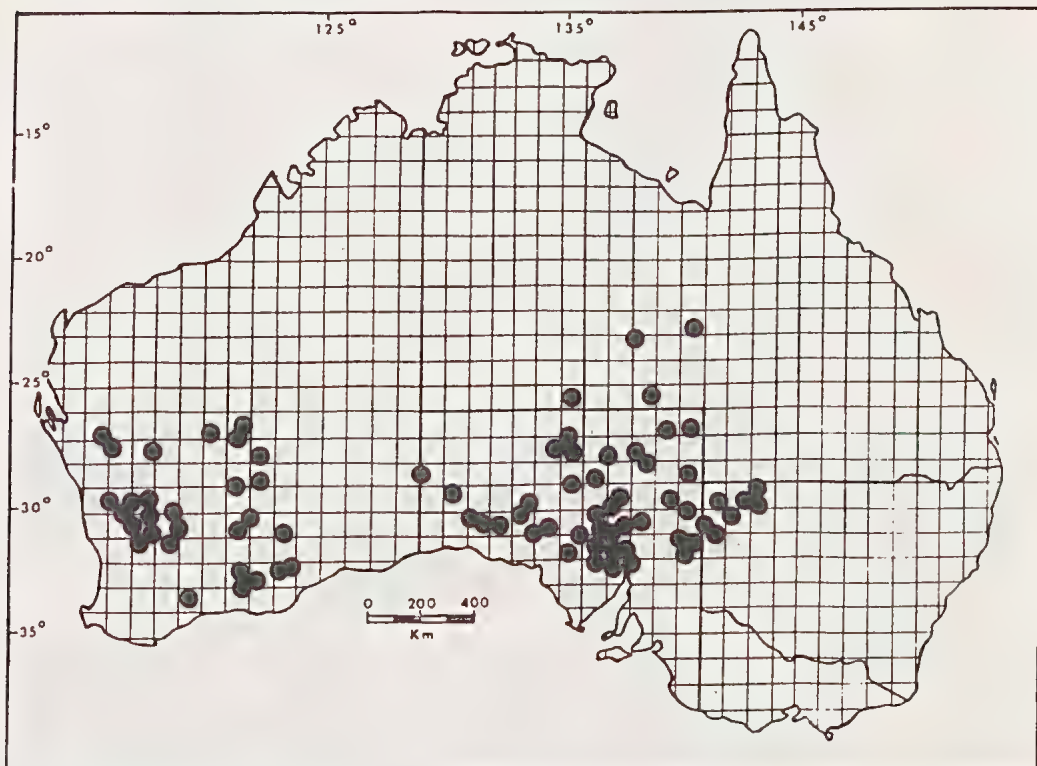
Notes

Although no infraspecific subdivision of this species has been attempted it is acknowledged that the majority of Western Australian populations are more robust than those further to the east. Leaves in these former populations are generally more erect and much longer, ranging from 17-80 mm, while in eastern populations they rarely exceed 15 mm in length although some plants produce leaves up to 28 mm. The size of the flower also varies considerably with Western Australian forms normally being larger. However, small leaf and flower forms do occur randomly in Western Australia, while robust forms with larger flowers and leaves occur occasionally in South Australia.

A population 19 km north of Marla Bore in northern South Australia (*Chincock 5514*) was found remarkable in that all flowers had consistently pinkish-purple anthers and ovary while they are usually pale yellow and green respectively.

Selected Specimens (collections seen: 198)

WESTERN AUSTRALIA: *A.M. Ashby 2561*, E of Murchison road crossing near Twin Peaks Station, 18.viii.1968 (PERTH, AD); *B.G. Briggs*, 3 miles SE of Morawa, 1.x.1960 (NSW 147633); *R.J. Chincock 755*, Beru Pool, Yelma Station, 5.ix.1973 (AD); *R.J. Chincock 5137*, Lake Raeside, 11.3 km S of Leonora, 13.x.1981 (AD); *C.A. Gardner s.n.*, Gilmores, v.1924 (PERTH); *A.S. George 5968*, Ponton Creek, N of Zanthus, 9.xi.1963 (PERTH); *J.W. Green 830*, 5 miles W of Cowcowing Lakes, 4.xi.1956 (PERTH); *J. Young s.n.*, near Mt Churchman, no date, (MEL 99620).



Map 2. Distribution of *G. quadrifida*.

NORTHERN TERRITORY: *N. Forde* 788, 10 miles W of Andado Homestead, 16.iv.1957, (NSW); *T.S. Henshall* 1977, Andado Station Homestead, 17.iv.1977 (AD, NT); *H. Kempe s.n.*, near Charlotte Waters, 1852 (MEL 99609); *W. Schwartz s.n.*, Charlotte Waters, 1889 (MEL 99613); *S.A. White s.n.*, MacDonnell Ranges, no date, (AD 97734342).

SOUTH AUSTRALIA: *R.F. Aiten* 6, Roxby Downs, 15.v.1981 (AD); *R.J. Chinnock* 2683, 2684, Yarle Lakes, 30.ix.1975 (AD); *N.N. Donner* 1764, 65 km E of Coober Pedy, 9.ix.1966 (AD); *B.G. Lay* 190, Half Moon Lake, Commonwealth Hill Station, 27.xi.1970 (AD); *K.D. Rohrlach* 849, Lake Gardner on island c. 8 km from shore, south end, 1.i.1962 (AD); *D.E. Symon* 12579, Serpentine Lakes near island S of crossing on Connie Sue Highway, 25.viii.1980 (ADW).

QUEENSLAND: *H. Clarke s.n.*, Mulligan River, ii.1904, (NSW 147630); *A. Henry s.n.*, Georgina River, 1889 (MEL 99610); *M. Olden* 761 & *D.E. Boyland*, 15 km NNW of Roebucks Tank, 26.v.1978 (AD, BRI); *R.W. Purdie* 1154, 141 km from Birdsville on the new Betoota road, 18.ix.1977 (AD, BRI).

NEW SOUTH WALES: *Beckler s.n.*, near the Barrier Range, 28-29.xii.1861, (MEL 99605, 99606); *J. Campbell & J. Pickard* 1258, 3.5 km N of Turleys Gate, 18.xi.1970 (NSW); *G.M. Cunningham* 503, Delalah Downs, 18.viii.1972, (NSW); *G.M. Cunningham & P.L. Milthorpe* 1068, Cobham Lake, 45 km SE of Milparinka, 16.ix.1973 (NSW); *E.N.S. Jackson* 2884, 28 km ESE of Whyjonta Bore, 12.v.1977 (AD); *S. Jacobs* 3047, Yantara Lake, 5.v.1977 (NSW).

2. *Gunniopsis tenuifolia* Chinnock, sp. nov.

Frutex foliis longis, tenuibus, teretibus, glabris praeter pilis basi marginibus; floribus parvis fasciculatis super foliis; perianthii segmentis connatis, interne flavovirentibus; staminibus fasciculis 4 segmentis alternantibus; filamentis teretibus papillois; capsula ovoidea; seminibus ovoideis, atro-brunneis, granulatis.

Type: *R.J. Chinnock* 5492, 22.6 km N of Leigh Creek South, South Australia, 27.i.1982 (holotype: AD; isotypes CANB, K, NSW, NT).

Etymology: Latin *tenuifolius*, slender leaved.

Shrub 0.5-0.9 x 0.5-1.7 m, compact, rounded. *Branches* green to orange-brown turning stramineous, minutely papillose towards tips, smooth in older parts, glabrous. *Leaves* green or brownish-green, at first reddish at base, linear-terete, subterete at base, apex acute, (15-) 28-65 x 0.7-2 mm, glabrous except on margins at base; fascicles of small leaves of shortened lateral branches often in leaf axils along main branches. *Flowers* small, pedicellate, distinctly aggregated into a small terminal inflorescence, leaves subtending the flowers distinctly smaller than on vegetative branches, 6-16 mm long. *Perianth* fused basally; segments almost equal, triangular, acute to acuminate, becoming rigid and spreading at the fruiting stage, 4.5-7.7 x 2.5-4.7 mm; outside surface green to reddish, smooth; inside surface yellow-green, finely papillose. *Stamens* numerous in 3-5 whorls, grouped in four bundles, alternate with perianth segments; filaments terete, papillose; anthers smooth. *Ovary* 4-ribbed, papillose; stigmas smooth. *Capsule* 4-ribbed, 3.5-5.5 x 3.5-6.7 mm; valves when opened emarginate, obtuse. *Seed* 1.4-1.8 x 1.2-1.5 mm, ovoid, blackish-brown, shiny, granulate. (Figs 11, 37, 38; Map 4).

This species, which is related to *G. quadrifida*, is restricted to South Australia extending from Leigh Creek north-west to the Arkaringa Hills. In the vicinity of Leigh Creek the species grows on stony slopes of low hills but it also extends down on to clay flats and depressions subject to periodic flooding where it dominates or co-dominates with *Halosarcia* species (Fig. 38). Near Hermit Hill NW of Marree the species grows on light-brown clay flats under open mallee woodland. One specimen (*Lay* 651), the species is recorded as growing along erosion channels in shale residuals.

Specimens examined

SOUTH AUSTRALIA: *R.J. Chinnock* 5849, 5490, 22.6 km N of Leigh Creek South, 27.i.1982 (AD); *R.J. Chinnock* 5502, 8.2 km N of Leigh Creek South, 21.ix.1982 (AD); *R.J. Chinnock* 5503; 66.4 km NW of Marree near Hermit Hill, 21.ix.1982 (AD); *B. Lay* 651, Back Mulga Paddock, Millers Creek Station, 13.x.1971 (AD); *T.R.N. Lothian* 123, Leigh Creek, 8 km N of the town towards north field, 29.ix.1959 (AD); *T.R.N. Lothian* 2125, Arkaringa Amphitheatre, c. 80 km SW of Oodnadatta, 15.viii.1963 (AD); *T.R.N. Lothian* 4998, north field, Leigh Creek, 18.x.1968 (AD); *D.E. Symon* 11175, S of Hermit Hill, 2.x.1978 (AD, ADW); *D.E. Symon* 11478, Arkaringa Hills, 21.x.1978 (AD, ADW).

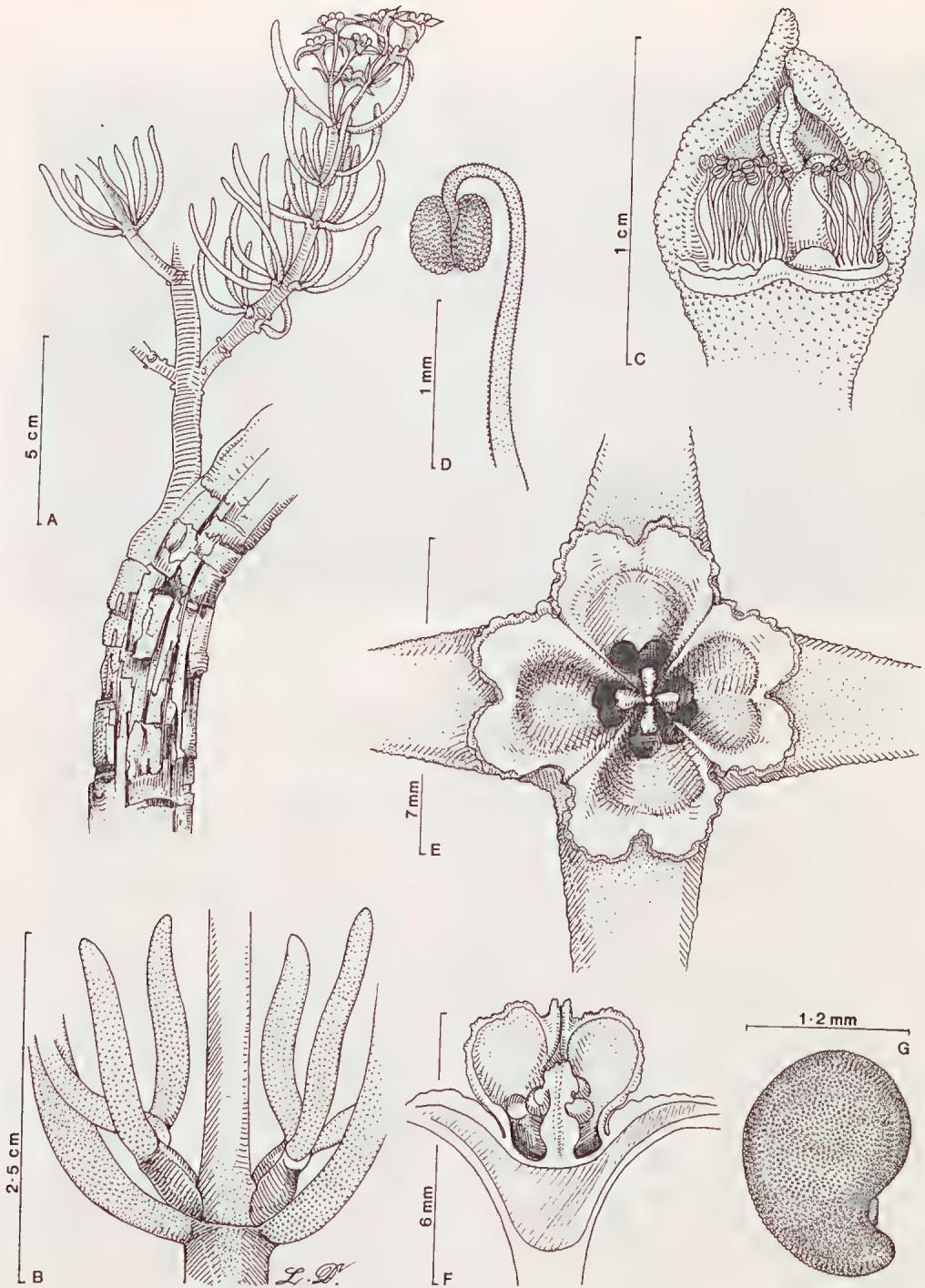


Fig. 37. *Gunniopsis tenuifolia*. A, portion of major stem showing deeply fissured bark and branch with leaves and fruits; B, enlargement of branch; C, longitudinal section through the flower showing the stamen bundles; D, stamen; E, open capsule; F, longitudinal section through capsule; G, lateral view of seed (based on *Chinnoek 5489*).



Fig. 38. Stony flats dominated by *G. tenuifolia*, Leigh Creek, South Australia.

3. *Gunniopsis zygophylloides* (F. Muell.) Diels in Diels & Pritzel, Bot. Jahrb. 35: 197 (1904); Maiden & Betche, Cens. N.S.W. Pl. 74 (1916); Black, Fl. S. Aust. edn 1, 221 (1924).

Type citation: "Trans montem Margaret: B. Herschel Babbage".

Type: *B. Herschel Babbage s.n.* (Hergolt), towards Mt Margaret, (South Australia). 1871 (holotype: MEL 99635).

Aizoon zygophylloides F. Muell., Fragm. 7: 129 (1871); Ewart & Davies, Fl. N. Terr. 106 (1917); Black, Fl. S. Aust. edn 2: 341 (1948) p.p.; Toelken in Jessop, Fl. Cent. Aust. 36 (1981) p.p.

Shrub 15-40 x 15-80 cm, compact. *Branches* green to stramineous, pubescent, hairs succulent, clavate but flattened and plate-like when dry, translucent, crisped. *Leaves* green or yellow-green, ovate to obovate, acute, tapering towards base, base slightly dilated and \pm auriculate when dry, 16-60 x 5-31 mm, surface distinctly papillose, moderately clothed, at least when immature, with flattened crisped hairs. *Flowers* scattered along flowering branches, pedicellate. *Perianth* fused basally; segments almost equal, triangular, acute, 7.5-14 x 3-7.3 mm; outside surface green, sparsely clothed with flattened crisped hairs; inside surface yellow, minutely papillose. *Stamens* numerous, in 2 or 3 whorls, evenly distributed around the ovary; filaments dilated and flattened in lower part, terete in upper part and minutely papillose; anthers smooth. *Ovary* prominently 4-ribbed and depressed at apex, papillose; stigmas papillose. *Capsule* prominently 4-lobed, deeply depressed at apex, (3.5-) 5-8 x (3.2-) 4.5-8.5 mm; valves when open cucullate, emarginate. *Seed* 1-1.2 x 0.8-1 mm ovoid, black, colliculate. (Fig. 39; Map 3).

Unlike most species of *Gunniopsis*, which favour saline sites, *G. zygophylloides* occurs in rocky situations in ranges and on shaly or quartzite residuals of Central South Australia and southern Northern Territory. More rarely this species occurs on gibber flats or in gravel along river courses, e.g. Finke River.

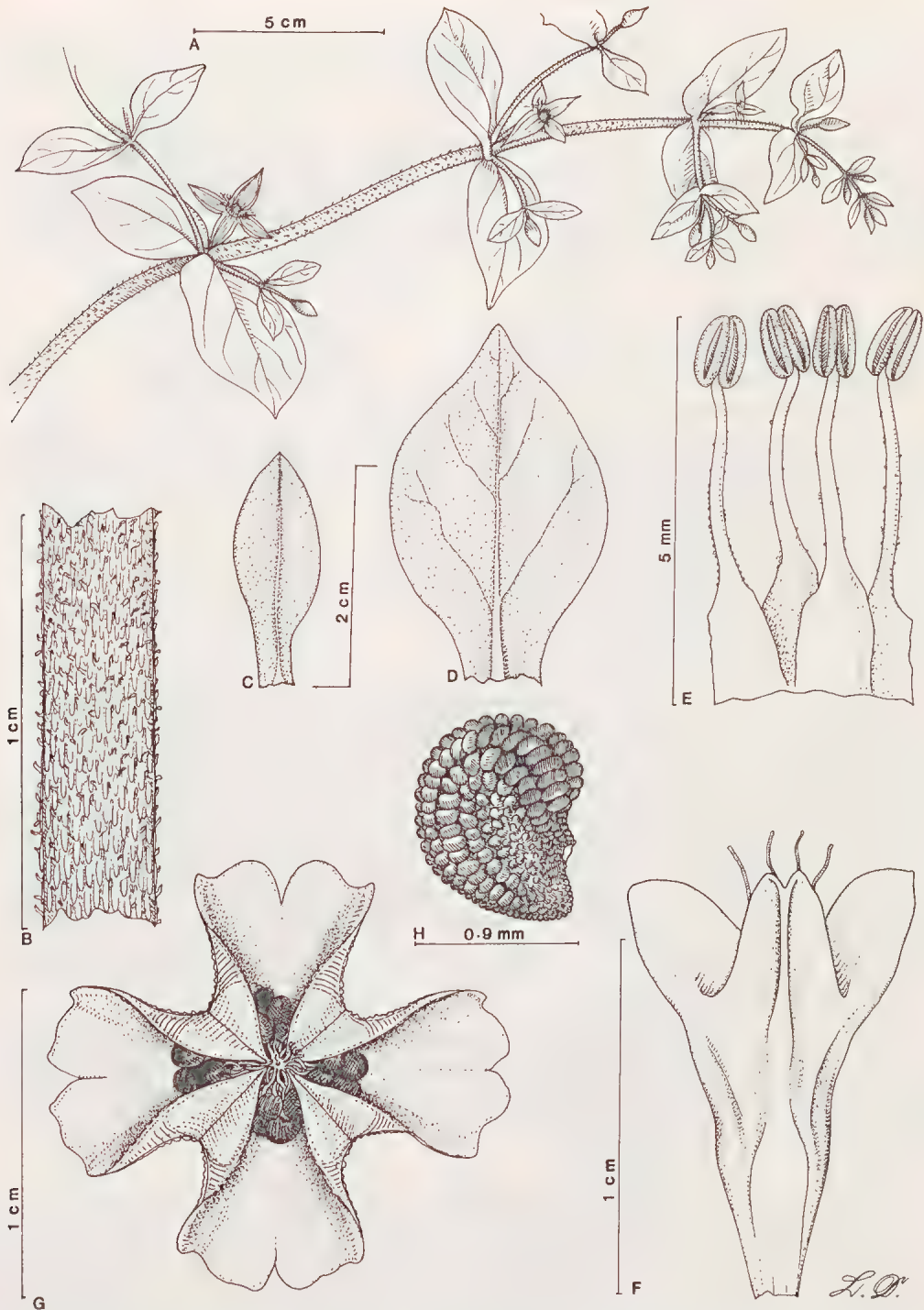


Fig. 39. *Gunniopsis zygophylloides*. A, habit of prostrate branch; B, enlargement of branch; C-D, variation in leaves; E, stamens showing the flattened bases; F, lateral view of capsule; G, opened capsule; H, lateral view of seed (A, B, D, Munir 5077; E-H, Pastoral Board of South Australia AD 97912199; C, Chinnock 2564).

Selected specimens (collections seen: 47).

NORTHERN TERRITORY: *G. Chippendale s.n.*, Henbury, 5.viii.1954 (AD, NSW, NT); *G. Chippendale s.n.*, 1.4 m N of Horseshoe Bend, 11.x.1957 (AD, NSW, NT); *P. Hooper s.n.*, First Bore, Victory Downs Station, 9.vii.1967 (AD); *P.K. Latz 248*, 19 m W of Henbury, 9.xii.1968 (AD); *T.R.N. Lothian 704*, near Finke River, Henbury Station, 1954 (AD); *W. Schwartz s.n.*, Charlotte Waters, 1889 (MEL 99645); *R. Tate s.n.*, Chandlers Range, no date (AD 97109458).

SOUTH AUSTRALIA: *R.J. Chinnock 2564*, 10 km WNW of Hogarth Hill, 25.ix.1975 (AD); *R.J. Chinnock 5513*, 9.5 km E of Mt Willoughby on the Copper Hills road, 22.ix.1982 (AD); *N.N. Donner 1706*, 58 km N of Kingoonya, 8.ix.1966 (AD); *E.H. Ising s.n.*, Evelyn Downs, 6.viii.1955 (AD 97608467); *R.W. Jessup s.n.*, Miller's Creek Station, Spring, 1950 (ADW 6827); *B. Lay 661*, 10 km N of Bon Bon Homestead, 16.x.1971 (AD); *T.R.N. Lothian 2681*, "8 mile digging": Coober Pedy, 2.v.1964 (AD); *D.E. Symon 11481*, Arckaringa Hills, 21.x.1978 (ADW).

4. *Gunniopsis calcarea* Chinnock, sp. nov.

G. quadrifida var. *zygophylloides* sensu Blackall & Grieve, West Aust. Wildfls 1: 163 (1954).

G. zygophylloides sensu Gardner, Enum. Pl. Aust. Occid. 2: 42 (1930).

Frutex perennans ramis foliis pedicellis et segmentis perianthii lepidotis; *foliis* carnosis lanceolatis; *perianthii segmentis* connatis anguste lanceolatis interne citrinis; *staminibus* aequaliter distributis circum ovarium; filamentis manifeste infra alatis; *capsula* 4-valvi valvis manifeste elevatis acutis cucullatis ubi apertis apexibus bifidis; *seminibus* ovoideis colliculosis.

Type: *R.J. Chinnock 5086*, 4.2 km NW of Eucla, Western Australia, 7.x.1981 (holotype: AD; isotypes BRI, CANB, K, MEL, NSW, NT, US).

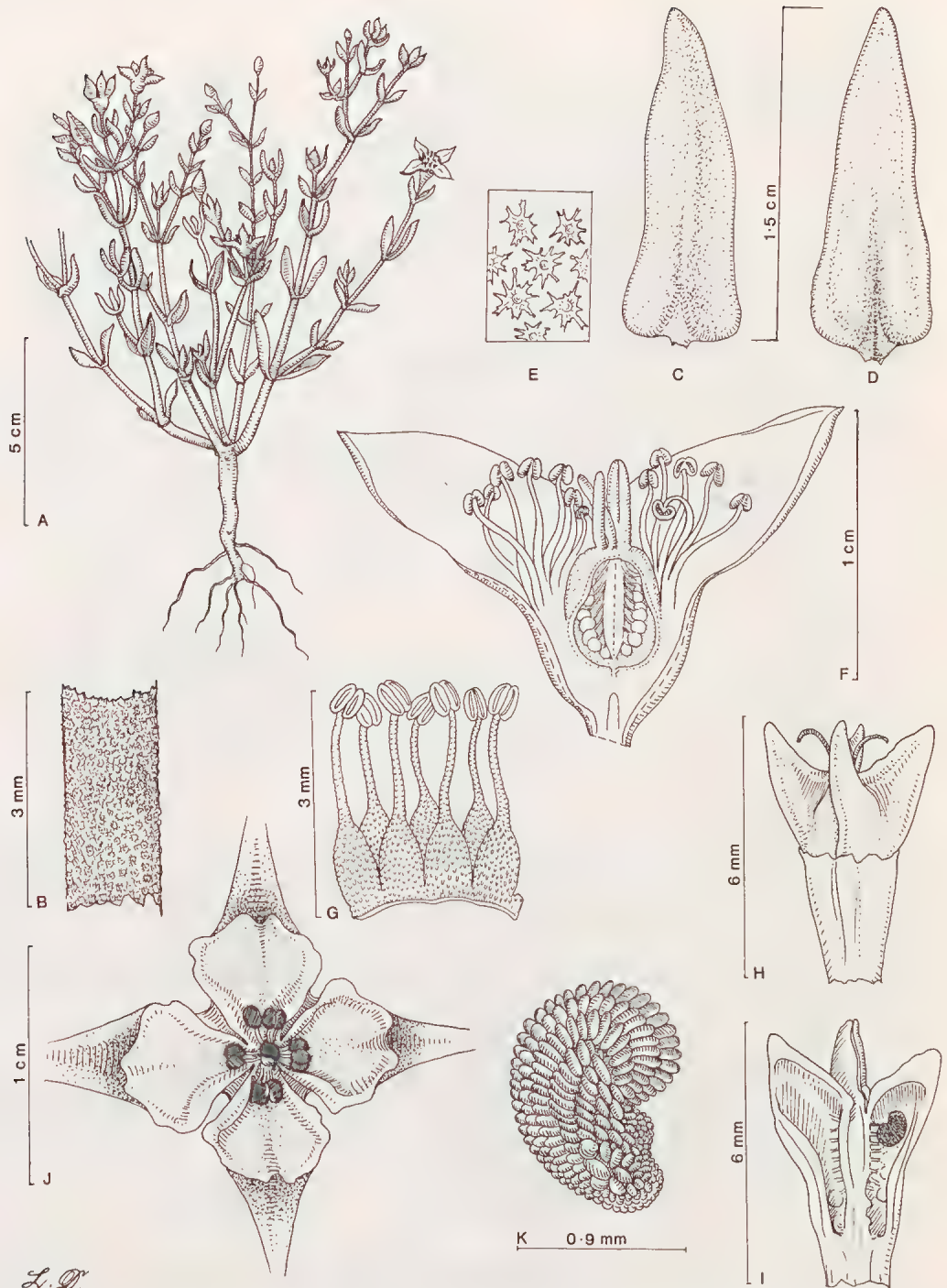
Etiymology: Latin *calcareus*, limestone; alluding to the restriction of this species to the Nullarbor Plain on skeletal calcareous soils.

Shrub 10-20 x 10-80 (-140) cm, compact. *Branches* densely white lepidote but older woody branches often \pm glabrous; scales appressed, margins irregularly branched. *Leaves* bright green or yellow-green, fleshy, linear-lanceolate to lanceolate, tapering to base, apex acute, 8-28 x 1.7-4.5 mm, densely white lepidote when immature but soon becoming sparsely lepidote. *Flowers* pedicellate. *Perianth* fused basally; segments almost equal, narrowly triangular, acute, 3.5-8 x 1.7-4 mm; outside surface green but turning reddish after flowering, sparsely to densely lepidote; inside surface yellow, papillose. *Stamens* numerous, in 2 or 3 whorls, evenly distributed around the ovary; filaments flattened in lower part, terete in upper part, papillose; anthers papillose. *Ovary* shallowly 4-ribbed in upper part, depressed at apex, papillose; stigmas smooth. *Capsule* 4-lobed, 4-7 x 3-6.7 mm; valves acute, when opened cucullate, with apex emarginate. *Seed* 1-1.1 x 0.8-1 mm, ovoid, dark brown to blackish-brown, colliculate. (Figs 13, 29, 30, 31, 40; Map 3).

Gunniopsis calcarea is restricted to the Nullarbor where it grows on skeletal calcareous brown earths, especially in shallow depressions with *Halosarcia* and *Maireana* species where it often co-dominates with them. It also occasionally occurs in open places in low mallee-*Melaleuca* scrubland.

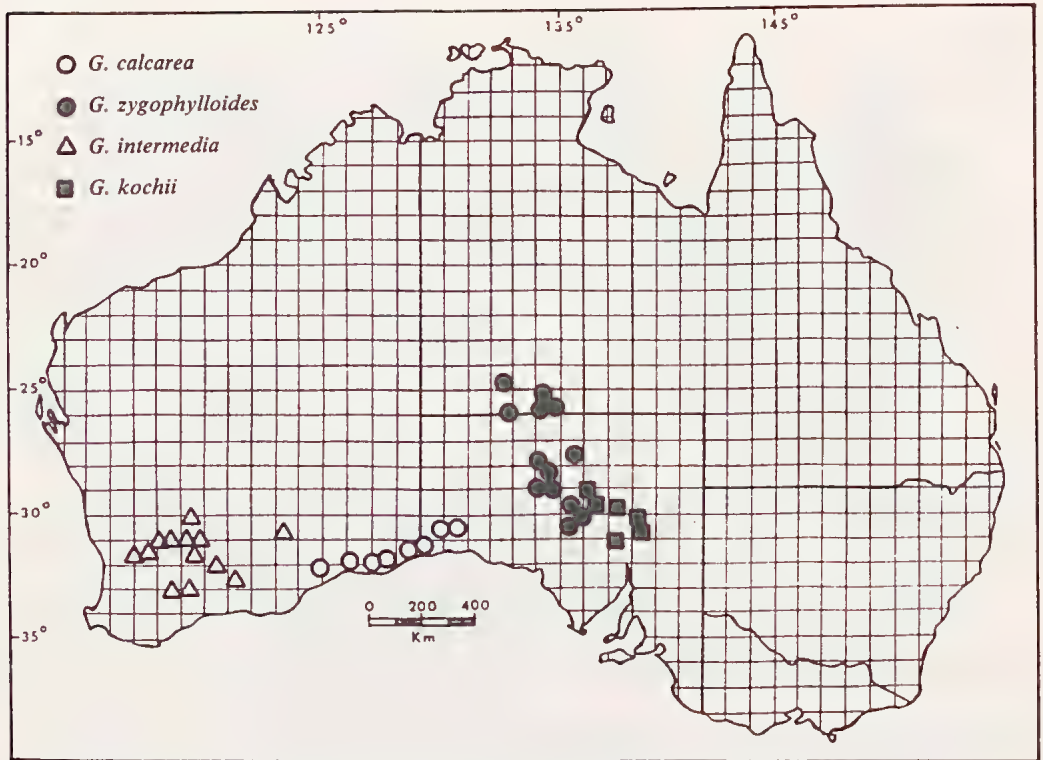
Notes

There is one mixed collection at PERTH consisting of *G. calcarea* and *G. quadrifida* which was collected at Gilmores (SW of Norseman) by Gardner. This record of *G. calcarea* is discounted for two reasons. Firstly, Gardner stated that the flowers were white which is obviously a reference to *G. quadrifida*. Secondly, the range; *G. calcarea* stops abruptly just east of Balladonia on the edge of the Nullarbor and it is not known to occur from any locality further west. Gardner collected *G. calcarea* two days after his visit to Gilmores, east of Balladonia, so that it seems likely that a specimen became mixed in with his Gilmores collection of *G. quadrifida*.



L. D.

Fig. 40. *Gunniopsis calcarea*. A, habit of small plant; B, enlargement of branch showing clothing of scales; C-D, lower and upper side of leaf respectively; E, enlargement of leaf surface to show details of scales; F, longitudinal section through flower; G, group of stamens; H, lateral view of capsule; I, longitudinal section through capsule; J, open capsule; K, lateral view of seed (based on *Chinnock 5468*).



Map 3. Distribution of *G. calcarea*, *G. intermedia*, *G. kochii* and *G. zygophylloides*.

Selected specimens (collections seen: 36)

WESTERN AUSTRALIA: *J.D. Batt s.n.*, Eucla, 1889 (MEL 99631); *R.J. Chinnock 3345*, 3.2 km NNW of Eucla Motel, 12.x.1976 (AD, PERTH); *R.J. Chinnock 5464*, 46.6 km W of Caiguna, 8.xi.1981 (AD); *R.J. Chinnock 5466*, 2.6 km E of Madura, 9.xi.1981 (AD); *C.A. Gardner & W.E. Blackall 1212*, near Balladonia, 29.x.1931 (PERTH); *P.G. Wilson 5819*, 5 km W of Cocklebidy, 17.v.1967 (PERTH).

SOUTH AUSTRALIA: *B.G. Briggs s.n.*, 21 miles E of Eucla, 27.ix.1960 (NSW 147629); *R.J. Chinnock 5470*, 25.2 km E of the SA/WA border, 9.xi.1981 (AD); *D.E. Symon 4492*, Koonalda Cave, 16.ii.1967 (ADW); *D.J.E. Whibley 660*, 2 km W of Cook, 16.ix.1960 (AD).

5. *Gunniopsis intermedia* Diels in Diels & Pritzel, Bot. Jahrb. 35: 197 (1904); Gardner, Enum, Pl. Aust. Occid. 2: 42 (1930); Erickson et. al., Fls & Pl West. Aust. 122 (1973).

Type citation: "Herb. in distr. Coolgardie australi pr. Gilmores in eucalyptetis lapidosoluto-s (subnitrosus?) flor. m. Nov. (D. 5462)".

Type: *Diels 5462*, Gilmores, W. Australia, 6.xi.1901 (holotype: B, destroyed; isotype: MEL 99601).

Herb 3-25 x 3-50 cm, erect or prostrate. *Branches* when fresh green to red-brown, shiny, smooth, becoming stramineous and longitudinally striated when dry. *Leaves* bright green to brownish-green, oblong, oblanceolate to spatulate, obtuse, slightly channelled above, dilated at base and \pm auriculate, 21-72 x 3.2-20 mm, smooth, shiny. *Flowers* pedicellate. *Perianth* fused basally; segments narrowly triangular, acute, 5.7-9.8 x 2-4 mm; outside surface green to yellow-green, smooth; inside surface bright yellow

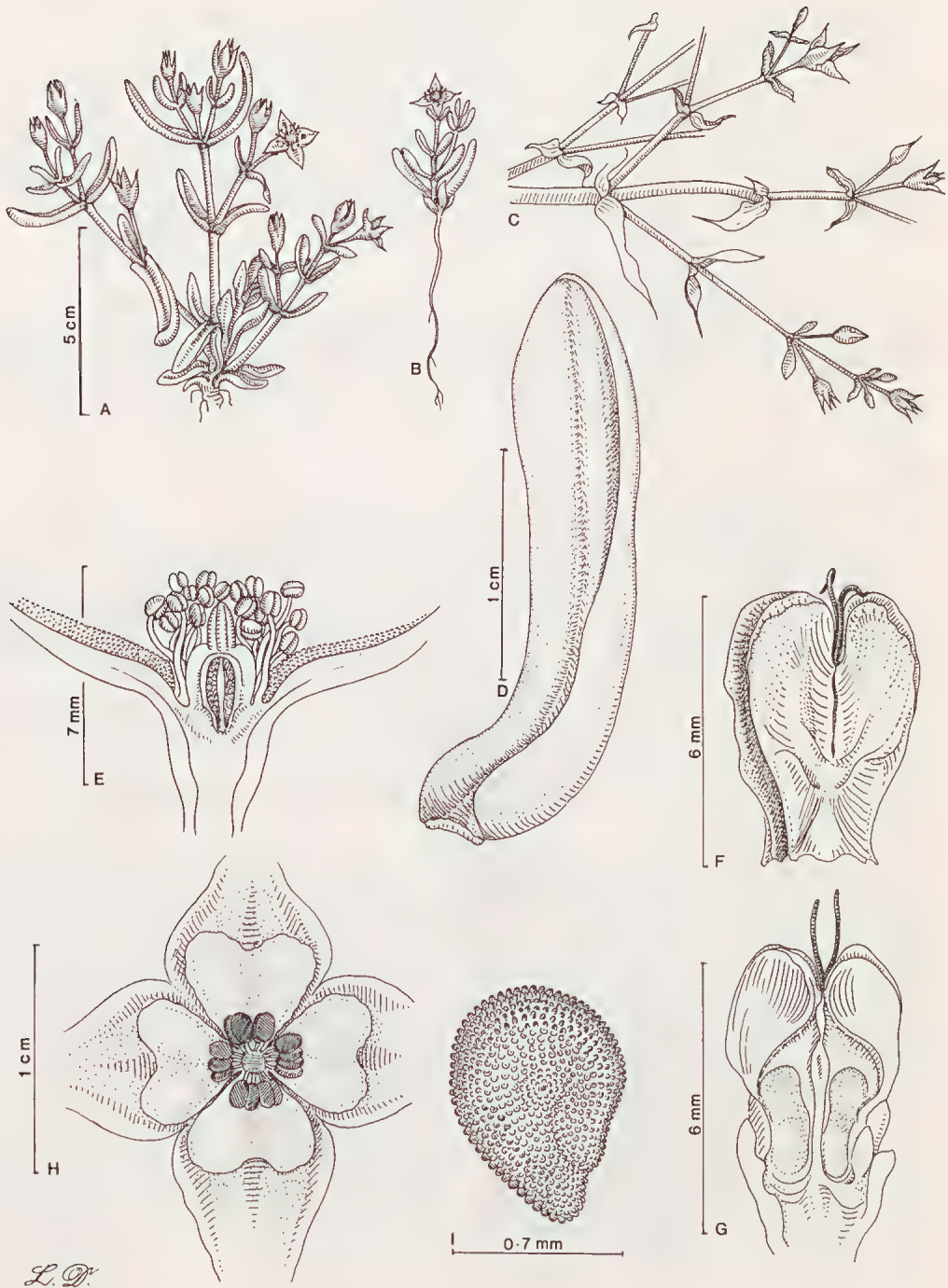


Fig. 41. *Gunniopsis intermedia*. A, small plant; B, depauperate plant; C, prostrate branch of large plant; D, leaf; E, longitudinal section of freshly opened flower; F, lateral view of fruit; G, longitudinal section through capsule; H, open capsule; I, lateral view of seed (based on *Chinnock 5406*).

eventually fading to white, minutely papillose. *Stamens* numerous, in 2 whorls, evenly distributed around ovary; filaments flattened in lower part, terete in upper part, minutely papillose; anthers minutely papillose. *Ovary* prominently 4-ribbed, smooth; stigmas papillose. *Capsule* prominently 4-winged, depressed at apex, 3.5-5.5 x 3.3-4.8 mm; valves when open cucullate, emarginate. *Seed* 0.8-1 x 0.6-0.8 mm, broadly ovoid, dark blackish-brown, finely tuberculate. (Figs 5, 6, 18, 41; Map 3).

Gunniopsis intermedia is commonly found on flats and sandy rises around the margins of salt lakes often in open *Melaleuca* or *Eucalyptus* shrubland or on the upper edges of *Halosarcia* low shrubland. Widespread throughout the Roe, Avon and Coolgardie Botanical Districts of Western Australia.

Selected specimens (collections seen: 23)

WESTERN AUSTRALIA: *W. E. Blackall* 981, 48 km E of Southern Cross, 9.x.1931 (PERTH); *R. J. Chinnock* 4360, Eclipse Lake, c. 12 km NW of Lake Bidy, 11.xi.1978 (AD); *R. J. Chinnock* 4416 and *P. G. Wilson*, Mortlock River just E of Meckering, 22.xi.1978 (AD); *N. N. Donner* 1367, 69 km WSW of Kalgoorlie, 29.ix.1965 (AD); *W. V. Fitzgerald s.n.*, Cunderdin, xi.1903 (NSW 147623, PERTH); *A. S. George* 5909, Ponton Creek, N of Zanthus, 22.ix.1963 (PERTH); *H. R. Toelken* 6515, NE end of Lake Johnston, 9.x.1979 (AD).

6. *Gunniopsis papillata* Chinnock, sp. nov.

Gunniopsis zygophylloides sensu Black, Fl. S. Aust. edn 1. 221 (1924), p.p.

Aizoon zygophylloides sensu Black, Fl. S. Aust. edn 2. 341 (1948, 1963) p.p.; Toelken in Jessop, Fl. Cent. Aust. 37 (1981) p.p.; Jacobs & Pickard, Pl. NSW. 61 (1981); Cunningham et al., Pl. West. N.S.W. 292 (1982).

Planta herbacea ramis erectis vel prostratis; ramis pubescentibus raro glabris; foliis oblongis ad oblanceolatis, obtusis, papillosis vel glabris; perianthii segmentis connatis, internis albis vel citrinis; staminibus numerosis aequilater distributis circum ovarium; filamentis glabris infra complanatis; capsula 4-lobata; seminibus ovoideis fere circularibus, atro brunneis, subtiliter tuberculatis.

Type: *J. Z. Weber* 5747, 10 km S of Curdamurka along the creek to Stuart Creek Homestead, South Australia, 3.x.1978 (holotype AD; isotypes BRI, K, MEL, MO, NSW, P, PERTH, PRE, NT, US).

Etymology: Latin *papillatus*, having papillae; alluding to the papillae which cover the branches and leaves.

Herb 2-10 x 2-70 cm, erect or prostrate. *Branches* pubescent at least towards the branch tips or rarely glabrous, hairs clavate, succulent, drying flat and crisped. *Leaves* green, oblong to oblanceolate, obtuse, (9.5-) 18-36 x 2.5-12 mm, papillose to rarely almost smooth. *Flowers* pedicellate. *Perianth* fused basally; segments ovate to triangular, acute, 4.4-9.5 x 2.3-4.9 mm; outside surface green, papillose; inside surface yellow or white, papillose. *Stamens* numerous, in 2-3 whorls, evenly distributed around ovary; filaments terete, or flattened in lower part in the outermost whorls, papillose; anthers minutely papillose. *Ovary* 4-ribbed, papillose; stigmas papillose. *Capsule* 4-lobed, depressed at apex, 4.7-7 x 4.5-5 mm; valves when open bifid. *Seed* 0.9-1.1 x 0.7-0.9 mm, ovoid to almost circular, dark brown, finely tuberculate. (Figs 15, 42; Map 6).

This species is usually found along ephemeral creek beds, swales and in depressions on gibber flats on saline loams or clays where it often dominates. It is particularly common in central South Australia and also occurs in the extreme NW of New South Wales and from a few scattered localities in Queensland. There are two old records from Charlotte Waters in the Northern Territory.

Notes

The colour of the perianth in this species appears to be either white or yellow. Although reference to pink forms has been made on some herbarium labels from South

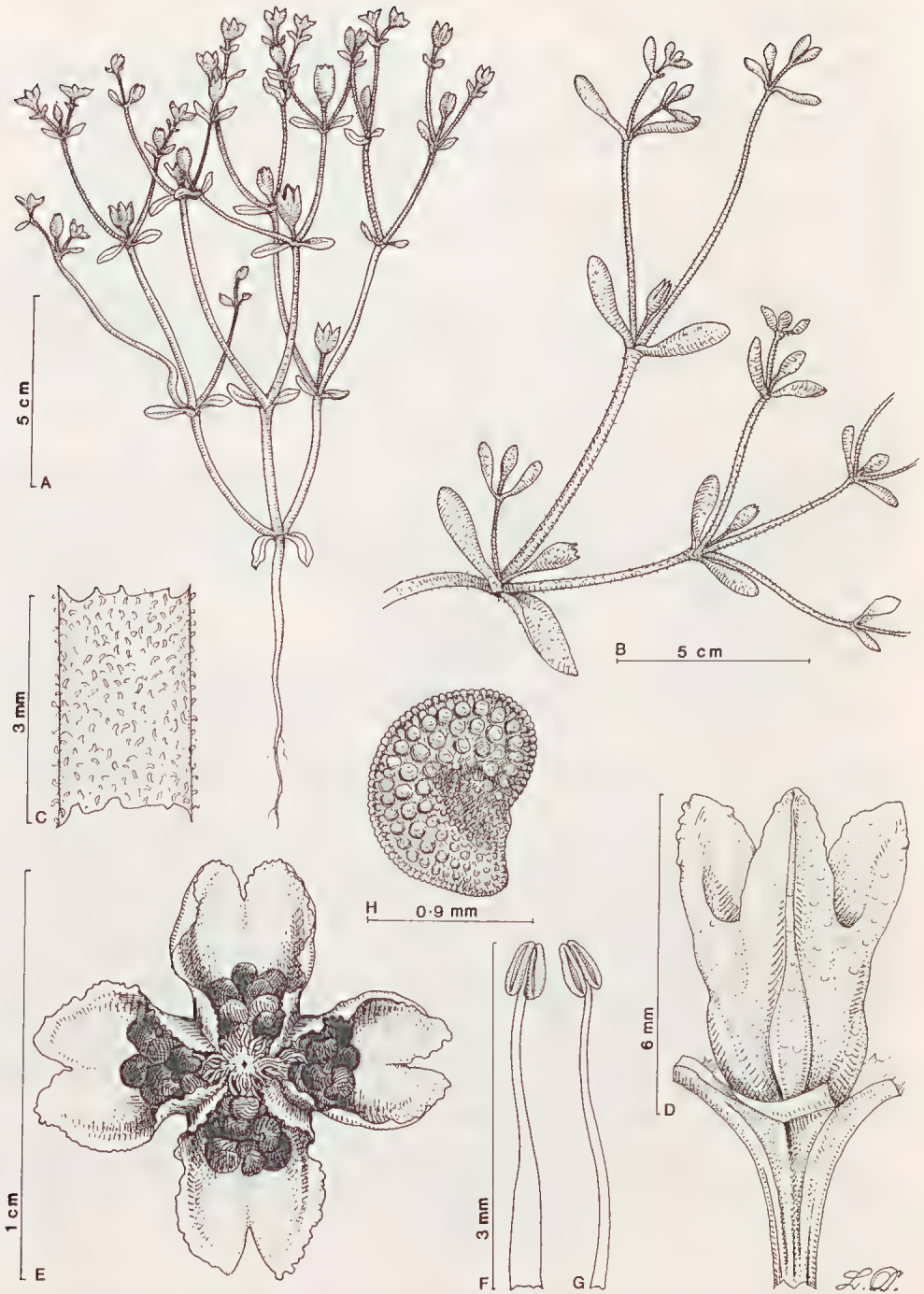


Fig. 42. *Gunniopsis papillata*. A, habit of small plant; B, prostrate branch of large plant; C, enlargement of branch; D, lateral view of capsule; E, open capsule; F-G, stamens of inner and outer whorl respectively; H, lateral view of seed (A, C-H, Weber 5747, B, Lothian 1295).

Australian localities, it is thought that these probably refer to plants of *Gunniopsis kochii* which is vegetatively very similar and occurs sympatrically with *G. papillata* in the south-eastern part of its range.

Forms of this species, with glabrous branches although uncommon, occur occasionally in the northern parts of South Australia and in the vicinity of Mt Isa in Queensland. These plants also lack the prominent papillae which cover the leaves of the typical form and the tubercles on the seed testa are not as pronounced.

Selected specimens (collections seen: 54)

NORTHERN TERRITORY: *H. Kempe 44*, near Charlotte Waters, 1885 (MEL 99647); *W. Schwartz s.n.*, Charlotte Waters, 1889 (MEL 99648).

SOUTH AUSTRALIA: *N.T. Burbidge & M. Gray s.n.*, Hawks Nest Tank to Wintinna, 9.x.1955 (CANB 4613); *K. Chorney 926*, 15 km SE of Coward Springs, 2.x.1978 (AD); *B. Copley 2195*, 8 km E of Anna Creek, 3.ix.1968 (AD); *N.N. Donner 1745*, 16 km E of Coober Pedy, 8.ix.1966 (AD); *E.H. Ising s.n.*, Evelyn Downs, 13.x.1953 (AD 97608475); *M. Koch 224*, Mt Lyndhurst, x.1898 (AD, HO, NSW); *R. Schodde 971*, c. 15 km W of Leigh Creek, 12.x.1958 (AD); *D.E. Symon 9345*, Dalhousie Springs, 23.ix.1974 (ADW).

QUEENSLAND: *Dr Morgan s.n.*, Diamantina River, viii.1930 (AD 968071005); *R.T. Perry 1*, Boulia—Mt Isa, 13.viii.1974 (BRI); *A. Tully s.n.*, Quilpie, ix.1955 (BRI 277088).

NEW SOUTH WALES: *W. Baurber s.n.*, near Wilcannia, 1887 (MEL 99638); *G.M. Cunningham & P.L. Milthorpe 1163*, Olive Downs, c. 35 km N of Tibooburra, 18.ix.1973 (NSW); *P. Johncock s.n.*, Mt Wood to Harton Park, 16.viii.1967 (NSW 147618); *A. King s.n.*, near Barrier Range, 1887 (MEL 99639); *J. Nobel W684*, Mt King near Tibooburra, x.1973 (NSW); *R.A. Perry 5726*, Mt King Station, 2.ix.1971 (NSW); *J. Pickard s.n.*, 1.5 km E of Gumhole Tank, 35 km NW of Tibooburra (NSW).

7. *Gunniopsis kochii* (Wagner) Chinnock, comb. nov.

Aizoon kochii Wagner, Ann. Naturhist. Hofmus. 19: 80 (1904); Toelken in Jessop, Fl. Cent. Aust. 36 (1981).

Type: *M. Koch 354*, Mt Lyndhurst, South Australia, Oct. 1898. (holotype W†; isotypes AD, MEL, NSW, PERTH).

Herb 10-25 x 15-30 cm, erect or prostrate, papillose. *Branches* green, prominently papillose or sparsely pubescent, hairs succulent, clavate. *Leaves* green, oblong to oblanceolate, obtuse, 10-25 (-47) x 3-9 (-15) mm, papillose or rarely with scattered succulent clavate hairs on margin. *Flowers* pedicellate. *Perianth* fused basally; segments ovate to triangular, acute, 5-9 x 3-5.2 mm, green outside, prominently papillose, pink inside, minutely papillose. *Stamens* numerous in 2-3 whorls, evenly distributed around ovary; filaments terete or distinctly flattened in lower part in outer whorls, glabrous; anthers smooth. *Ovary* 4-ribbed, papillose; stigmas papillose. *Capsule* prominently 4-lobed, depressed at apex; valves when first opened becoming deeply bifid. *Seed* 0.5-0.7 x 0.4-0.6 mm, ovoid, laterally expanded into curved lobes mainly towards apex, colliculate, cells arranged in rows. (Figs. 12, 43; Map 3).

G. kochii is restricted to the Lake Eyre, Gairdner-Torrens and Flinders Ranges regions of South Australia where it occurs on stony soils, especially on gibber plains although one specimen (*Symon 11214*) was collected on sandy drifts in a subsaline creek bed.

Notes

Black (1924, 1948) confused this species with *G. papillata* (*G. zygophylloides* sensu Black) largely because these two species are vegetatively almost identical. It was, therefore, natural for him to assume that the perianth of *G. kochii* was merely a colour variant. The two species can be easily separated on their seed.

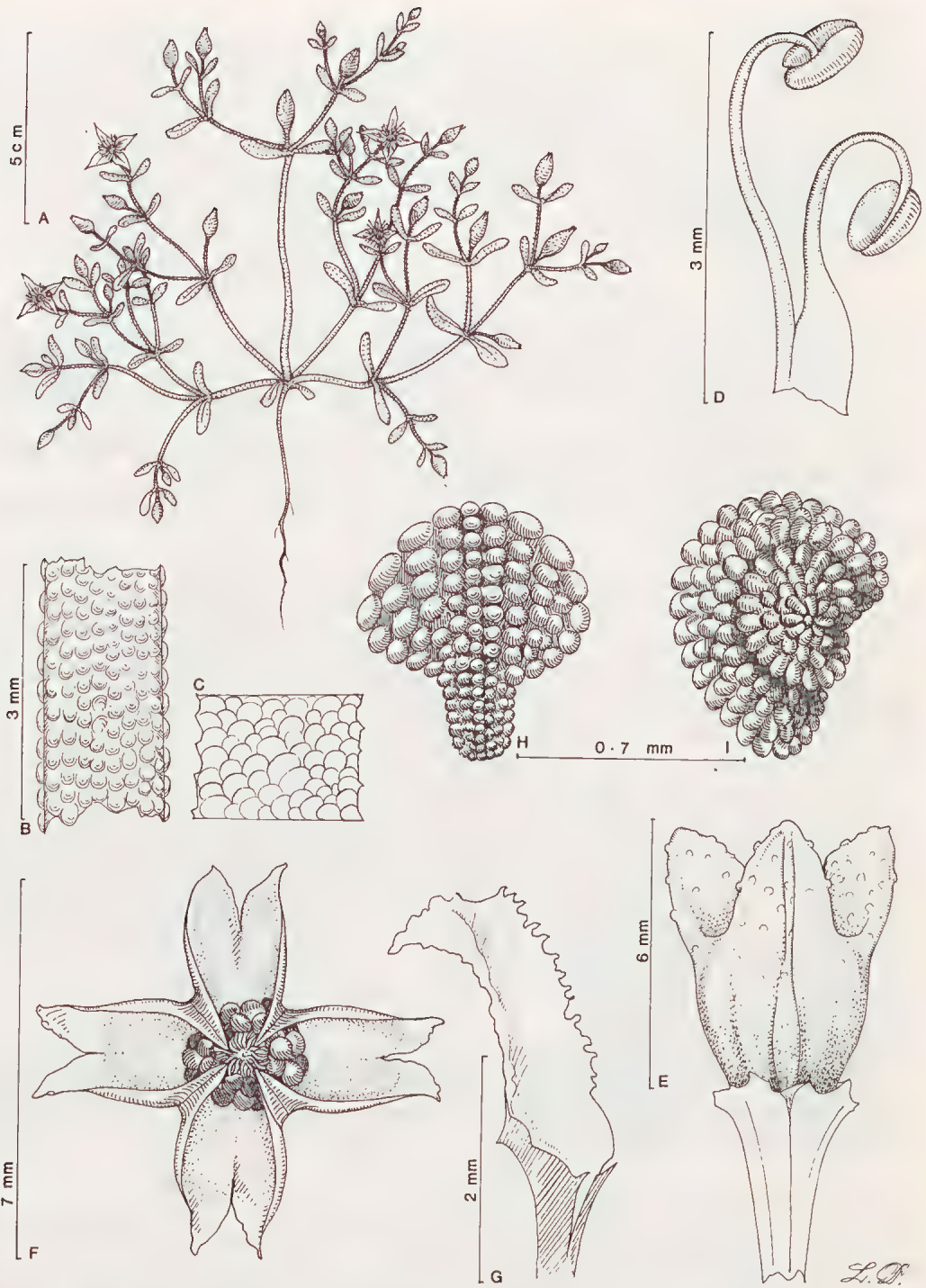


Fig. 43. *Gunniopsis kochii*. A, habit of plant; B-C, enlargement of branch and leaf respectively to show the prominently papillose epidermal cells; D, stamens; E, lateral view of capsule; F, open capsule; G, portion of valve to show the serrate expanding keel; H-I, distal and lateral views of seed (A, D, E-G, *Chorney 995*; B-C, *Symon 11161*; H-I, *Koch 354*).

Specimens examined

SOUTH AUSTRALIA: *F. Badman* 261, 3 km E of Curdimurka, 12.vii.1980 (AD); *K. Chorney* 995, Beresford Hill, 4.x.1978 (AD); *B. Copley* 2214, 6 km SW of Coward Springs, 3.ix.1968 (AD); *Hj. Eichler* 12979, between Leigh Creek and Copley, 3 km S of Leigh Creek, 26.ix.1956 (AD); *R. Hill* 327, Leigh Creek on railway, 1.viii.1955 (AD); *P. Horton* 181, near Hermit Hill Springs, 3.x.1978 (ADW); *T.R.N. Lothian* 1429, 4 miles W of Leigh Creek, 15.ix.1955 (AD); *R.L. Rodgers s.n.*, Coward Springs, 2.ix.1910 (NSW 147621); *R. Schodde* 970, 4 km NW of Copley near Leigh Creek, 12.x.1958 (AD); *R. Swinbourne* 91, Salt Creek, Carrapateena Arm, Lake Torrens, 5.ix.1968 (AD); *D.E. Symon* 11131, Strangways Springs, 1.x.1978 (AD, ADW); *D.E. Symon* 11264, Coward Springs 3.x.1978 (AD); *J.Z. Weber* 1320, Salt Creek, Carrapateena Arm, Lake Torrens, 5.ix.1968 (AD).

8. *Gunniopsis calva* Chinnock, sp. nov.

Planta herbacea ramis foliisque glabris saepe pustulatis crystallis epidermalibus salis protrudentibus; foliis oblanceolatis vel obovatis; perianthii segmentis connatis interne albis; staminibus aequilater distributis; circum ovarium; filamentis infra complanatis; capsula 4-valvi; valvis profunde bifidis; seminibus ovoideis, brunneis dilutis nitidis colliculosis.

Type: *Hj. Eichler* 18818, Sweet Nell Mines c. 5 km ENE of Woocalla Railway Station Siding, South Australia, 22.x.1966 (holotype: AD; isotype: CANB).

Etymology: Latin *calvus*, hairless, smooth; referring to the smooth branches and leaves of this species.

Herb 3-15 x 3-25 mm, erect or prostrate, glabrous. *Branches* green, smooth, striate when dry, often irregularly pustulate due to crystalline salt protruding from epidermal and sub-epidermal layers. *Leaves* green, oblanceolate, obovate to spatulate, obtuse, 10-35 x 3-12 mm, basal ones often slightly larger than those on the flowering branches, smooth or with scattered crystalline salt pustules. *Flowers* pedicellate. *Perianth* fused basally; segments triangular, equal or two segments longer with terete tips, apex acute, 4.5-13 x 3.5-6.5 mm; outside surface green, smooth; inside surface white, finely papillose. *Stamens* numerous, in 2-3 whorls, evenly distributed around ovary; filaments flattened in lower part, pubescent with hairs clavate; terete in upper part, glabrous; anthers smooth. *Ovary* shallowly 4-ribbed, smooth; stigmas crested. *Capsule* 4-lobed, 4-8 x 4-5.5 mm, when closed deeply depressed at apex between valves; valves when open deeply bifid almost to base so that capsule appears 8-valved. *Seed* 0.5-0.7 x 0.4-0.6 mm, ovoid; pale brown, shiny, colliculate, the cells arranged in rows. (Figs 8, 44; Map 4).

Common around the margins of salt lakes on northern Eyre Peninsula and in the Gairdner-Torrens region of South Australia.

Specimens examined

SOUTH AUSTRALIA: *Benbow* 3, Tarcoola, 31.x.1976 (AD); *R.J. Chinnock* 392, West shore of Lake Hart, 17.viii.1973 (AD); *P.E. Conrick* 287, Nonning, 7.xi.1979 (AD); *Hj. Eichler* 17627, southern end of Lake Hart, 21.ix.1963 (AD); *B. Flounders* 5, Lake Gilles, 1967 (AD); *E.N.S. Jackson* 537, Lake Hart, 5.ix.1963 (AD); *R.L. Specht* & *B.B. Carrodus* 110, 55 km N of Nonning Homestead, 16.xi.1958 (AD); *J.Z. Weber* 2890, 20 km E of Wilgena Station, 30.ix.1971 (AD).

9. *Gunniopsis divisa* Chinnock, sp. nov.

Aizoon glabrum Luehm. ex Ewart, Proc. Roy. Soc. Vic. n.s. 20: 128 (1908) p.p. as to the *Tyson* syntype of *A. glabrum* which is here designated as type of *G. divisa*.

Planta herbacea ramis foliisque glabris; perianthii segmentis fere liberis, internis albis; staminibus aequilater distributis circum ovarium; filamentis teretibus, infra hirsutis; capsula ovoidea; valvis acutis; seminibus ovoideis aspectu laterali in lobis curva lateraliter expansis, colliculosis.

Type: *I. Tyson* 3, Murchison River, 1898 (holotype: MEL 99600; isotypes: MEL 99597, MEL 99599, NSW 147627, K).

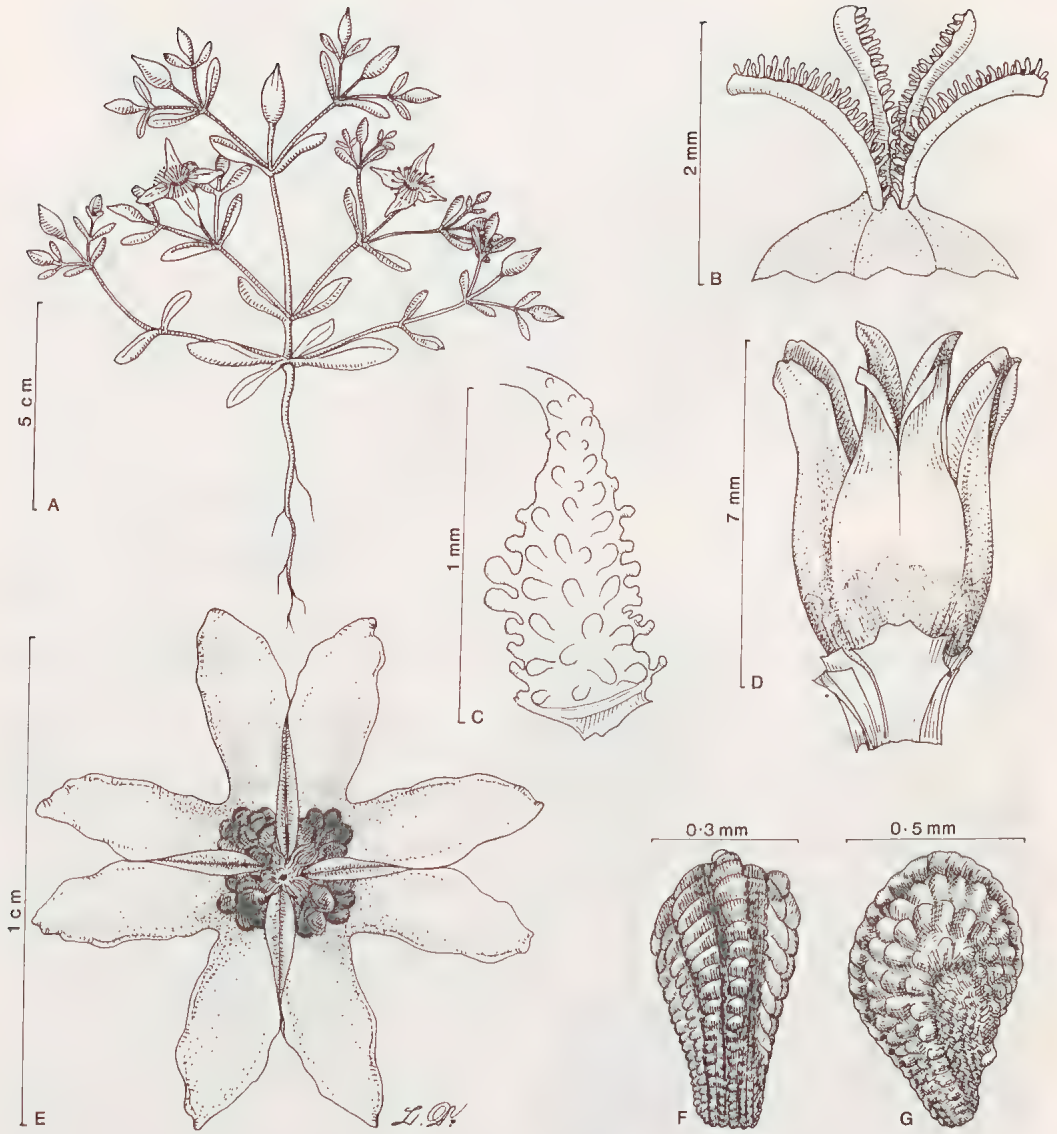
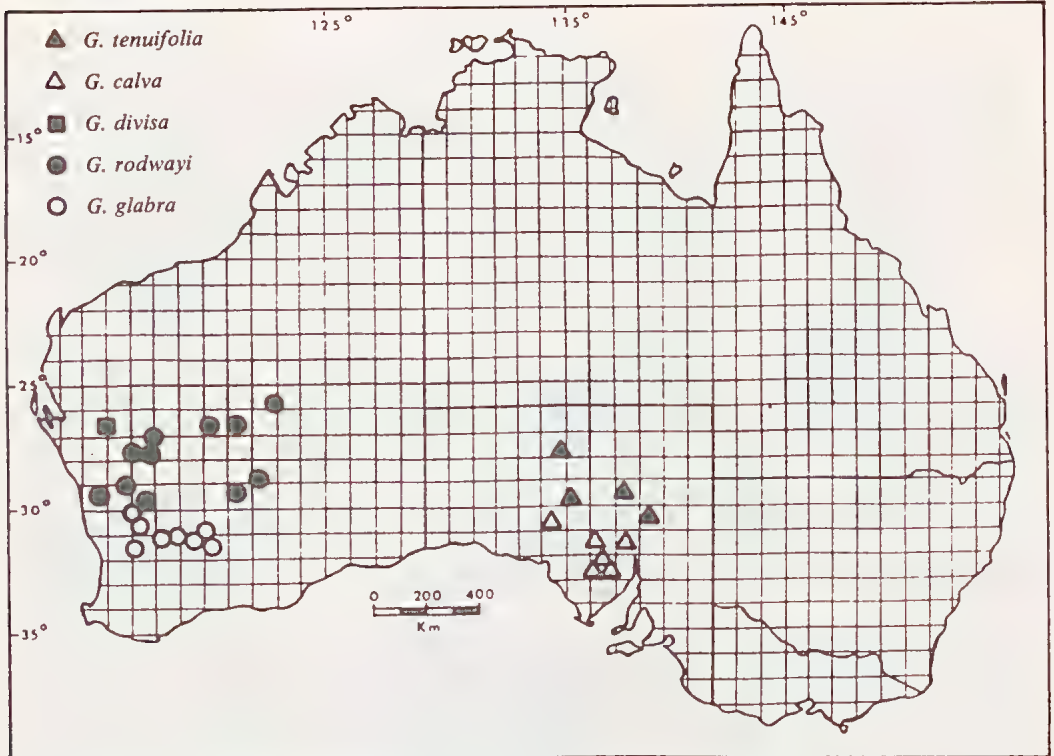


Fig. 44. *Gunniopsis calva*. A, habit of plant; B, prominently crested stigmas; C, base of filament; D, lateral view of capsule; E, open capsule; F-G, distal and lateral views of seed (A-C, Jackson 537; D-G and Specht & Carrodus 110).



Map 4. Distribution of *G. calva*, *G. divisa*, *G. glabra*, *G. rodwayi* and *G. tenuifolia*.

Etymology: Latin *divisus*, divided; referring to the perianth segments which are divided to the base.

Herb 5-10 x 10-15 cm, with erect and prostrate branches, glabrous. *Leaves* linear, flattened, 5-15 x 1.3-2 mm, scattered along flowering branches but with one or two pairs clustered under the receptacle; basal leaves not seen. *Flowers* shortly pedicellate. *Perianth* free; segments triangular, equal, acute, 7.5-12.2 x 3-4.5 mm, outside surface green, smooth; inside surface white, papillose. *Stamens* numerous, in 2-3 whorls, evenly distributed around ovary; filaments terete, hirsute in lower part, minutely papillose in the upper parts; anthers smooth. *Ovary* shallowly ribbed towards apex; smooth, stigmas papillose. *Capsule* shallowly ribbed, slightly depressed at apex, 4-7 x 4-5.5 mm; valves acute, not splitting, expanding keels prominent along margins. *Seed* 0.7-0.8 x 0.6-0.7 mm, dark-brown, ovoid, laterally expanded into curved lobes, colliculate but in lateral parts cells elongated, cells arranged in rows. (Figs 7, 14, 45; Map 4).

Although the type label of *G. divisa* gives only the vague locality "Murchison River" it seems likely that the species originated from the upper tributaries of this river. Indeed the only other collection known, which was also made by Isaac Tyson, was collected at Mt Narryer. Since a note in Tyson's handwriting accompanying this collection states that it was not numbered because he had sent some earlier this indicates that the exact type locality could be Mt Narryer.

In a note on one of the MEL isotypes Tyson stated that the species occurred on a conglomerate rise in "perfectly good soil" unlike a similar "flower" that he had sent earlier (described by Ewart as *Aizoon rodwayi*).

Other specimen examined:

WESTERN AUSTRALIA: *I. Tyson s.n.*, Mt Narryer, 1898 (K).

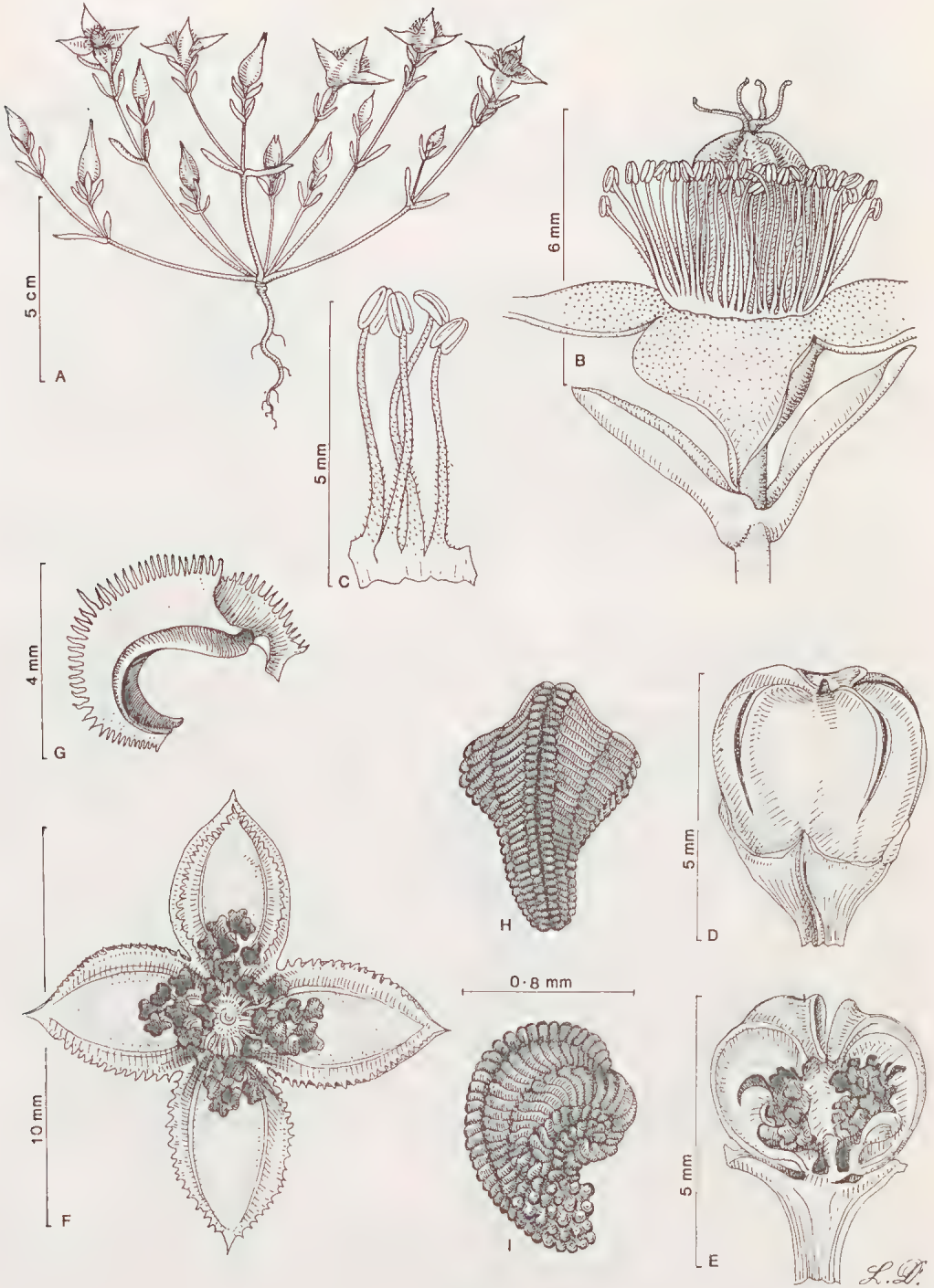


Fig. 45. *Gunniopsis divisa*. A, habit of plant; B, side view of flower; C, group of stamens; D, side view of capsule; E, longitudinal section through capsule; F, open capsule; G, lateral view of valve showing the prominently ciliate expanding keels; H-I, distal and lateral views of seed (based on *Tyson s.n.*, MEL 99600).

10. *Gunniopsis glabra* (Luehm. ex Ewart) Gardner, Enum. Pl. Aust. Occid. 2: 42 (1930); Blackall & Grieve, West. Aust. Wildfls 1: 163 (1954).

Type citation: "Murchison R., I. Tyson 1898; Mt Caroline 1891, Miss Sewell; Salt Lakes, Martha Heal".

Type: *Martha Heal s.n.*, Salt Lakes, no date (MEL 99596, lectotype here designated); syntypes: *Miss Sewell s.n.*, near Mt Caroline, 1891 (MEL 99598); *I. Tyson s.n.*, Murchison River, 1898 (MEL 99597, 99599, 99600).

Aizoon glabrum Luehm., ex Ewart, Proc. Roy. Soc. Vic. n.s. 20: 128 (1908); Beard, West. Aust. Pl. 31 (1975).

Typification

Ewart's circumscription of *Aizoon glabrum* was based on the three collections cited above but unfortunately they consist of two elements. The collections of Martha Heal and Miss Sewell are of a very distinct perennial species which stands apart from other species in the genus in having a fleshy taproot, very condensed branches clothed with persistent dilated leaf bases and inflorescences reduced to a solitary flower. Tyson's collections are of an herbaceous species similar to *G. rodwayi* in habit but differing in the perianth segments being divided to the base and seeds which in distal view are laterally expanded into lobes similar to that found in *G. kochii* (cf. *G. divisa*).

In lectotypifying *G. glabra* I have selected the taxon upon which fruit and seed characters appear to have been entirely based. Other vegetative and floral features have been drawn from both taxa and individual features of both species can be identified in the protologue.

Herb with usually a somewhat woody perennial base continued in a prominent taproot and with one to several rosettes above, glabrous. *Basal branches* condensed, solitary or branched, rarely more than 30 mm long, densely clothed in dilated, buff-coloured, papery, persistent leaf bases. *Flowering branches* 40-140 mm long, unbranched, wiry, glaucous grey-green tinged purple or blackish-purple, erect, spreading or prostrate. *Leaves* glaucous green to grey-green; basal ones subterete, flattened or slightly channelled on upper side, acute, dilated and sheath-like at base, 15-45 x 2-7 mm; leaves on flowering branches, lanceolate, more or less conduplicate, acute, 4.6-26 x 1.8-3 mm. *Flowers* solitary. *Perianth* fused basally; segments ovate to triangular, equal, acute, 7.5-12 x 4-6.3 mm, outside surface glaucous-green to grey-green, smooth; inside surface white, papillose. *Stamens* numerous, in up to 9 whorls, evenly distributed around ovary; filaments terete, hirsute in lower part, minutely papillose in upper part; anthers smooth. *Ovary* shallowly 4-ribbed, smooth; stigmas papillose. *Capsule* ovoid, obtuse, 4-7 x 4-8 mm; valves when open deeply bifid and capsule appearing 8-valved when closed. *Seed* 1-1.5 x 0.7-0.8 mm, ovoid, in distal view with a prominently truncate apex, black, coarsely tuberculate. (Figs 17, 32, 33, 34, 46; Map 4).

Widespread throughout the Avon and Coolgardie Botanical Districts of Western Australia where it occurs on sandy soils (rarely clay loam) on the margins of salt lakes.

Notes

Unlike the other species of *Gunniopsis*, which grow and flower from late winter to early summer, *G. glabra* has a distinctive vegetative phase and a delayed flowering period. Vegetative growth of the basal branches and leaves occurs during spring and at this stage the flowering stems elongate but the terminal solitary flowers do not develop. By November the basal leaves begin drying off and the flower buds start to enlarge. Flowering does not occur until late January or February and from cultivated plants it is suggested that the first opening of the flowers only occurs on extremely hot days.

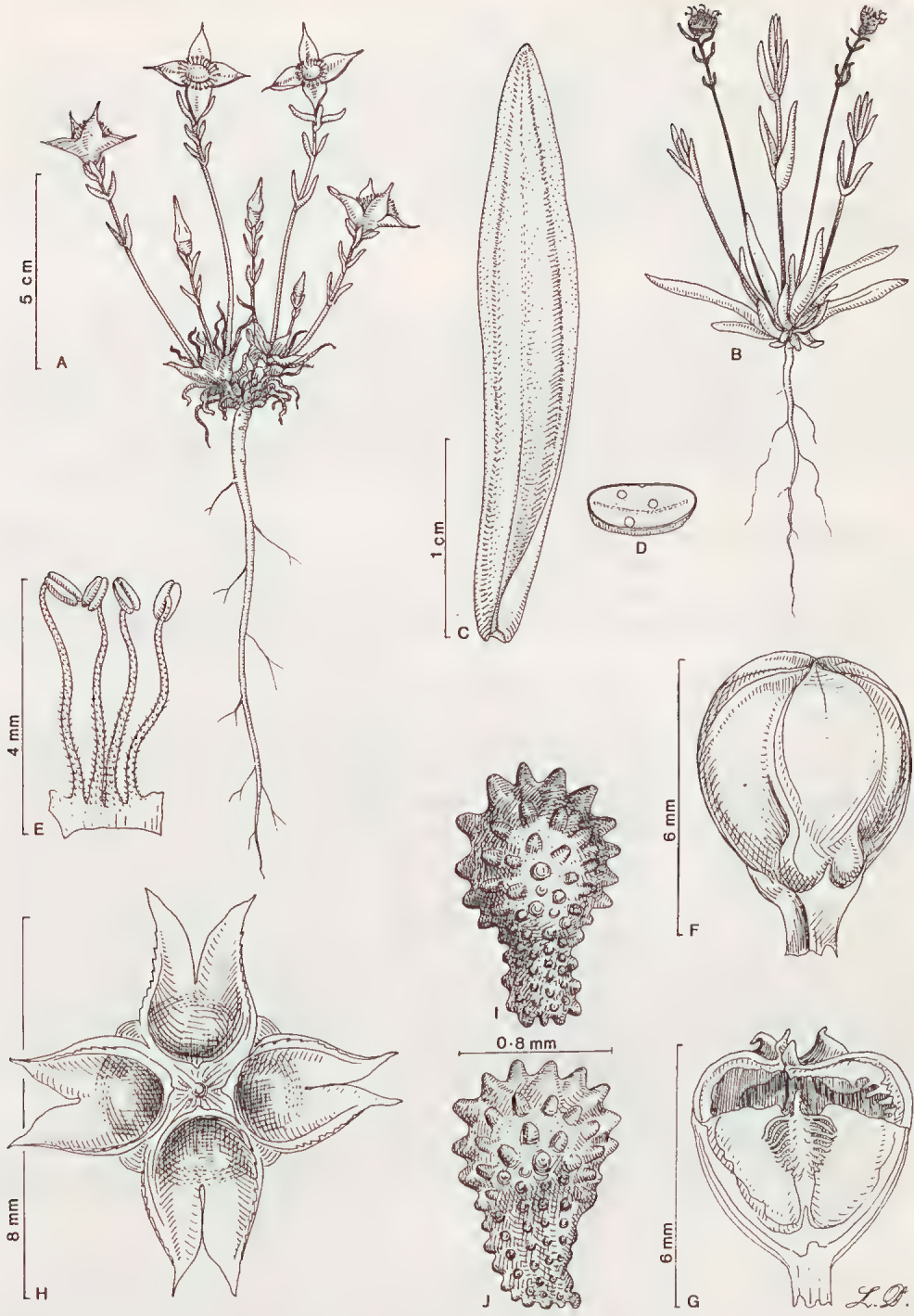


Fig. 46. *Gunniopsis glabra*. A, habit of flowering plant showing the dried up leaves; B, vegetative plant with the previous year's capsules and the young developing flowering branches; C, leaf; D, cross-section of leaf; E, group of stamens; F, lateral view of capsule; G, longitudinal section through capsule; H, open capsule; I-J, distal and lateral views of seed respectively (based on *Chinmook 5250*).

However, having once opened the flowers will continue to re-open each day for up to a fortnight or more irrespective of temperature.

One collection at PERTH (*W.H. Butler s.n.*) collected at Lake Barker Reserve is atypical of the species and may possibly be of hybrid origin or represent a new taxon. The basal portion of the plant consists of numerous densely clustered leaves (no root system is present) from which eighty flowering stems emerge. On most of these stems, lateral branches are suppressed but in the largest ones lateral shoots with flower buds are emerging from the leaf axils. It is possible that the plant may be a hybrid between *G. glabra* and *G. rodwayi*.

Specimens examined

WESTERN AUSTRALIA: *W.H. Butler s.n.*, Lake Barker Reserve, xi.1971 (PERTH); *R.J. Chinnock 4419* & *P.G. Wilson*, Mortlock River just E of Meckering, 22.xi.1978 (AD); *R.J. Chinnock 5250*, western side of Lake De Courcy, 20.x.1981 (AD); *R.J. Chinnock 5254*, Salt Lakes 43.6 km E of Wubin, 20.x.1981 (AD); *R.J. Chinnock 5407*, southern side of Lake Brown, 4.xi.1981 (AD); *R.J. Chinnock 5408*, Salt Lake 39.4 km W of Bullfinch, 4.xi.1981 (AD); *R.J. Chinnock 5422*, Salt Lake, 28.9 km S of Bullfinch, 4.xi.1981 (AD); *R. Helms s.n.*, near Yilgarn, xi.1891 (AD 97617619); *R. Helms s.n.*, near Knutsford, 8.xii.1891 (AD 97617622); *E. Merrall s.n.*, Yilgarn goldfields near Lake Brown, 1888 (MEL 99650); *K. Newbey 5889*, southern end of Lake Seabrook, 11.ix.1979 (PERTH); *R.D. Royce 8411*, Mortlock River, Meckering, 8.ii.1968 (PERTH).

11. *Gunnopsis rodwayi* (Ewart) Gardner, Enum. Pl. Aust. Occid. 2: 42 (1930); Blackall & Grieve, West. Aust. Wildfls 1: 163 (1954).

Type: *F.A. Rodway s.n.*, dried up Salt Lake, Desdemona, Western Australia, 1907 (MEL 99633, lectotype designated here); syntype; *Isaac Tyson s.n.*, Nannine Salt Marsh, 1893 (MEL 99634).

Aizoon rodwayi Ewart, Proc. Roy. Soc. Vic. n.s. 30: 129 (1908).

Herb 2-16 x 2-50 cm, erect or prostrate, glabrous. *Branches* at first glaucous grey-green, smooth or with scattered protruding salt pustules, on drying turning stramineous, striate. *Leaves* glaucous, grey-green, basal ones oblong, flat or slightly channelled, obtuse; leaves on flowering branches ovate to lanceolate, obtuse or acute, in side view \pm falcate, conduplicate, connate base clasping branch, 5.5-40 mm long. *Flowers* pedicellate. *Perianth* fused basally; segments ovate to triangular, two longer, with terete acuminate apices, 5-20 x 2.5-12 mm; outside surface glaucous grey-green, smooth or with protruding salt pustules; inside surface white, although sometimes the margins turning pinkish, papillose. *Stamens* numerous, in 2 (?3) whorls, grouped in four bundles alternate with segments or almost forming a continuous ring around ovary; filaments terete, hirsute in lower part, minutely papillose in upper part; anthers smooth. *Ovary* shallowly 4-ribbed in upper part, smooth; stigmas smooth. *Capsule* 4-ribbed, 5-5.5 x 4.5-6 mm; valves when opened deeply bifid and often appearing 8-valved. *Seed* c. 1.2 x 0.7-0.8 mm, ovoid, in distal view with prominently truncate apex, black, tuberculate. (Figs 19, 47; Map 4).

Widespread throughout the Austin, Ashburton and Avon Botanical Districts of Western Australia. Commonly found in sand around the margins of salt lakes, usually on the upper edges of *Halosarcia* low shrublands. It frequently occurs with *G. quadrifida*.

Notes

The habit of this species varies considerably depending on the availability of moisture during the growing period. With good rains or in positions such as on damp sand adjacent to pools, growth is very rapid with much branching resulting in large plants to 50 cm in diameter. Often, however, sufficient rains only fall to initiate germination and then they are not followed up by more to maintain growth so that depauperate plants result which have only one erect and a few prostrate branches which are usually little branched.



Fig. 47. *Gunniopsis rodwayi*. A, habit of medium sized plant with erect and prostrate branches; B, small plant with erect branches; C, group of stamens; D, lateral view of capsule; E, longitudinal section through capsule; F, open capsule; G-H, distal and lateral views of seed (based on *Chinnock 5169*).

Specimens examined

WESTERN AUSTRALIA: *B.G. Briggs s.n.*, 3 miles SE of Morawa, 1.x.1960 (NSW 147628); *R.J. Chinnock 763*, Beru Pool, Yelma Station, 5.ix.1973 (AD, PERTH); *R.J. Chinnock 4694*, 3.8 km E of Carnegie, 16.ix.1979 (AD); *R.J. Chinnock 5169*, Lake Annean, 5.8 km W of Nannine, 16.x.1981 (AD); *R.J. Chinnock 5186*, northern edge of Lake Austin 18.2 km S of Cue, 17.x.1981 (AD); *R.J. Chinnock 5225*, 13.9 km S of Metters Bore, Paynes Find—Cleary Road, 19.x.1981 (AD); *R.J. Chinnock 5270*, 7 km S of Morawa, 21.x.1981 (AD); *E. Clark 280*, E of Laverton, 1916 (PERTH); *C.A. Gardner 7810A*, Lake View Station, 20 m W of Cue, 12.x.1945 (PERTH); *C.A. Gardner 7847A*, Lake Annean, Nannine, 13.x.1945 (PERTH); *C.A. Gardner 12037*, near Lake Monger, 10.xii.1958 (PERTH); *N.H. Speck 1430*, 18 miles W of Yelma, 11.ix.1958 (AD, CANB, PERTH); *H.R. Toelken 6102*, 32 km E of Wiluna, 12.ix.1979 (AD); *P.G. Wilson 7290*, Lake Carey, northern margin c. 225 km NNE of Kalgoorlie, 26.viii.1968 (PERTH); *P.G. Wilson 11594*, Lake Austin, c. 18 km S of Cue, 14.ix.1973 (PERTH).

12. *Gunniopsis septifraga* (F. Muell.) Chinnock, comb. nov.

Gunnia septifraga F. Muell., Rep. Babb. Exped. 9 (1859); Benth., Fl. Aust. 3: 327 (1867); Pax in Engl. & Prantl. Nat. Pflanzenfam. 1st edn 3, 1: 43 (1894); Bailey, Qd Fl. 2: 707 (1900).

Type citation: "Stuart's Creek".

Type: *Hergolt s.n.*, Stuarts Creek, South Australia, 1858 (holotype: MEL 589314).

Gunnia drummondii Benth., Fl. Aust. 3: 327 (1867); Tate, Fl. Extratrop. S. Aust. 87 (1890); Black, Fl. S. Aust. edn 1: 221 (1924); Gardner, Enum. Pl. Aust. Occid. 2: 42 (1930); Blackall & Grieve, West. Aust. Wildfls 1: 163 (1954).

Type: *Drummond 241*, Swan River, no date (holotype: K).

Neogunnia drummondii (Benth.) Pax & Hoffm., in Engl. & Prantl, Nat. Pflanzenfam. 2nd edn 16c: 225 (1934).

Neogunnia septifraga (F. Muell.) Pax & Hoffm., in Engl. & Prantl, Nat. Pflanzenfam. 2nd edn 16c: 225 (1934); Black, Fl. S. Aust. edn 2: 340 (1963); Toelken in Jessop, Fl. Cent. Aust. 36 (1981); Jacobs & Pickard, Cens. Pl. N.S.W. 62 (1981).

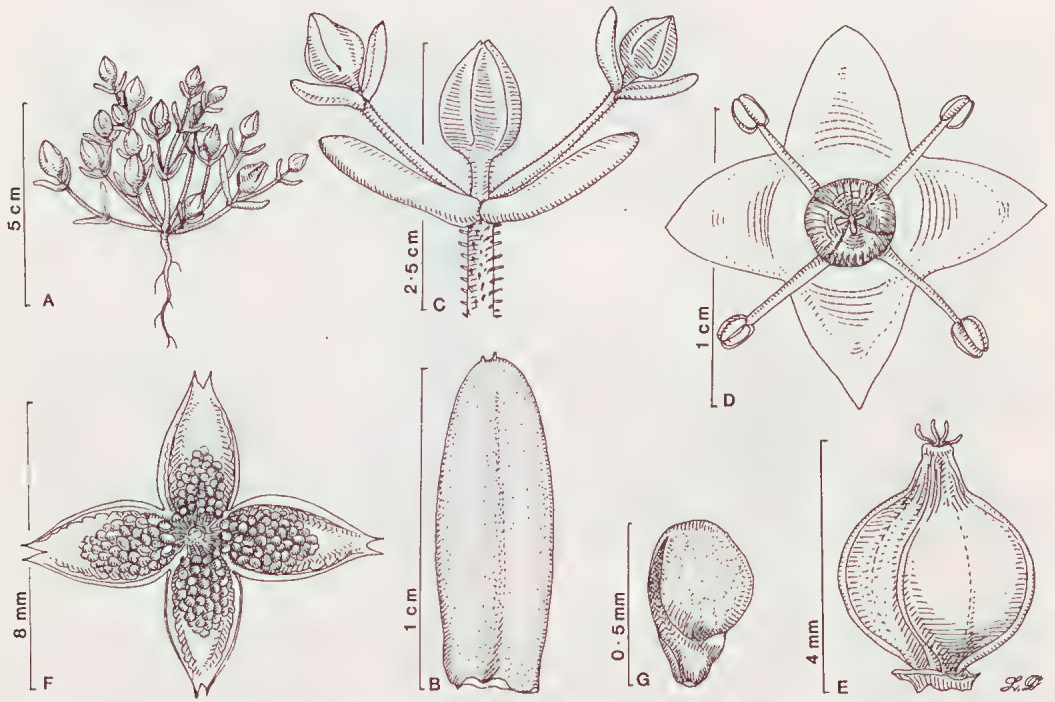
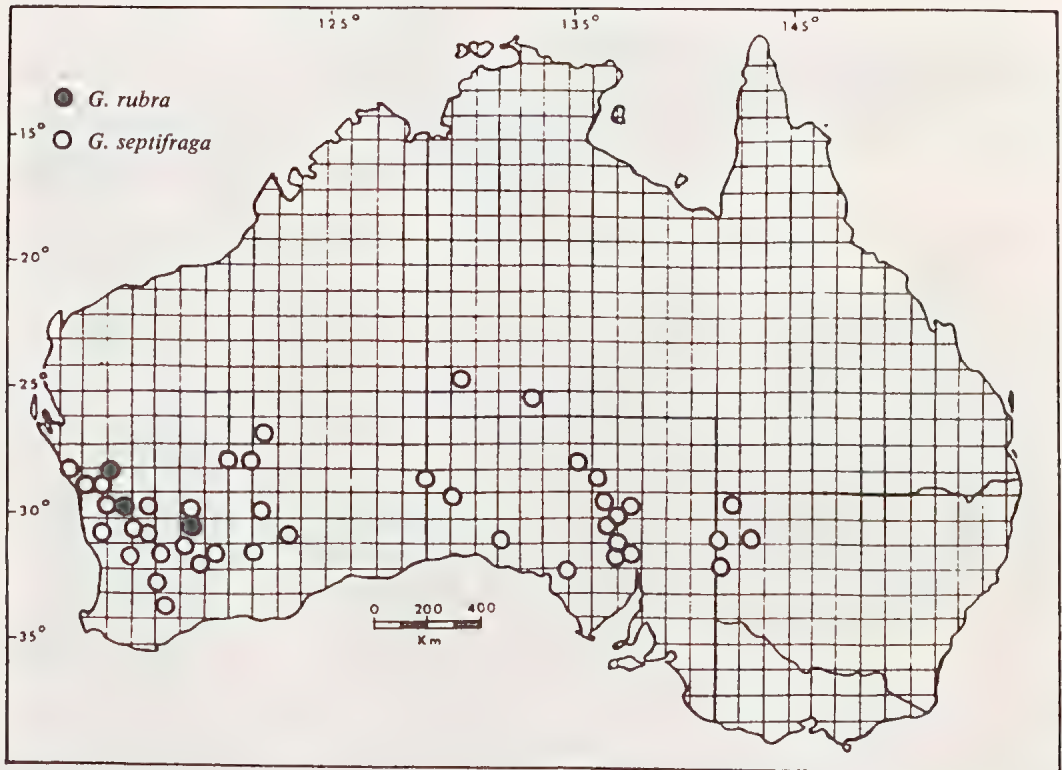


Fig. 48. *Gunniopsis septifraga*. A, habit of plant; B, leaf; C, habit of branch with flower buds and prominent succulent hairs; D, open flower; E, lateral view of capsule; F, open capsule; G, lateral view of seed (based on Chinnock 5286).

Herb 0.5-5 x 2-15 (-25) cm, prostrate, caespitose. *Branches* green to yellow, smooth, stramineous and striate when dry, glabrous or sparsely pubescent, hairs clavate. *Leaves* green turning yellow-green to stramineous as plant matures and dries off, oblong to oblanceolate, obtuse, 5-15 x 1.0-4.8 mm, glabrous. *Flowers* sessile or shortly pedicellate. *Perianth* fused basally; segments triangular, equal, acute, 2.4-6 x 2-6.2 mm; outside surface green to yellow, smooth; inside surface green, smooth to obscurely papillose. *Stamens* 4, rarely 8, in a single whorl, alternate with perianth segments; filaments terete but slightly flattened near base; anthers glabrous. *Ovary* 4-ribbed, smooth; stigmas papillose. *Capsule* 4-ribbed, tapering to a beak-like apex, 2.5-4.5 x 2.3-3.7 mm; valves emarginate to deeply bifid, and if latter, capsule when closed appearing 8-valved. *Seed* 0.5-0.7 x 0.3-0.5 mm, ovoid, whitish to hyaline but normally brown along distal side, obscurely rugose, or smooth except for rugose distal side. (Figs 10, 23, 24, 35, 48; Map 5).

Extremely widespread throughout the saline lake systems of Western and South Australia and extending into the southern Northern Territory and western New South Wales.

G. septifraga occurs in extremely saline situations and grows along the edges of, or on the damp bottoms of, salt lakes, salt pans or depressions. On lake margins this species often forms dense patches on open flats or around the bases of *Halosarcia* shrubs.



Map 5. Distribution of *G. rubra* and *G. septifraga*.

Selected specimens (collections seen: 57)

WESTERN AUSTRALIA: *J.S. Beard 2090*, Binnu, 28.ix.1962 (PERTH); *R.J. Chinnock 820*, 14.5 km SE of Windidda Homestead, 6.ix.1973 (AD, PERTH); *R.J. Chinnock 5383*, 14.5 km S of Pingrup, 2.xi.1981 (AD); *C.A. Gardner s.n.*, Mortlock River Flats, Meckering, 22.x.1945 (PERTH); *D.E. Symon 12640A*, Tjidilchurra Rockhole, 26.viii.1980 (ADW).

NORTHERN TERRITORY: *T.S. Henshall 2114*, Palmer Valley Station, 6 km NNE of Kingston No. 2 Dam, 6.ix.1978 (AD, NT); *J.R. Maconochie 1895*, Lake Neale, 28.viii.1973 (AD, MEL, NSW, PERTH); *J.R. Maconochie 2536*, Karinga Creek, 15.ix.1978 (AD); *R.W. Swartz*, Finke River, 1889 (MEL 99703, 99706).

SOUTH AUSTRALIA: *R.J. Chinnock 2727*, Ifould Lake, 2.x.1978 (AD); *B. Copley 2209*, 3 km from Coward Springs, 3.ix.1968 (AD); *E.H. Ising s.n.*, 12 miles S of Oodnadatta, 30.viii.1955 (AD 97651095, ADW); *T.R.N. Lothian 4044*, 55 km NE of Wirrula, 4.vi.1967 (AD); *D.E. Symon 2738*, 24 miles S of Woomera, 14.viii.1962 (ADW).

NEW SOUTH WALES: *G.M. Cunningham & P.L. Milthorpe 1172*, Nuntherungie, c. 40 km E of Lake Bancannia, 19.ix.1973 (NSW); *Mrs Irvine s.n.*, near Silverton, 1889 (MEL 99709); *Mrs Irvine s.n.*, Barrier Ranges, ix.1889 (MEL 997080); *S. Jacobs 4146*, 10 km W of Tibooburra, 8.ix.1981 (NSW).

13. *Gunniopsis rubra* Chinnock, sp. nov.

Planta herbacea parva prostrata glaber ramis foliis et floribus viridibus rubescentibus; foliis oblongis subteretibus; *perianthii segmentis* basibus divisus interne viridis; *staminibus* 4; *capsula* ovoidea obtusa; valvis 4 acutis; *seminibus* ovoideis brunneis dilutis laevibus nitidis.

Type: *R.J. Chinnock 5268*, 20 km SE of Perenjori, 21.x.1981 (holotype: AD; isotype: K, MEL, PERTH, NT, US).

Etymology: Latin *ruber*, red; referring to the colour the plant turns as it matures.



Fig. 49. *Gunniopsis rubra*. A, habit of large and small plant; B, leaf; C, enlargement of branch with flowers; D, open flower; E, lateral view of capsule; F, open capsule with persistent stigmas on tips of valves; G, lateral view of seed (based on *Chinnock 5268*).

Herb c. 1 x 2-12 cm, prostrate, glabrous. *Branches* green to red, smooth when fresh but striate when dry. *Leaves* green to red, oblong, subterete, flattened above, 3.5-10 x 0.7-1 mm. *Flowers* sessile or pedicellate. *Perianth* free; segments triangular, equal, apex terete and margins with large scattered papillae but not obvious in dried material, 2.5-4.5 x 1.3-2.1 mm; outside surface green to red, \pm rugose; inside surface green, smooth. *Stamens* 4, in a single whorl, alternate with the segments; filaments terete, glabrous; anthers smooth. *Ovary* globular, smooth; stigmas smooth. *Capsule* ovoid, with apex obtuse, membranous, 2-2.6 x 1.5-2.5 mm; valves 4, acute, not bifid at apex. *Seed* 0.4 x 0.25-0.3 mm, ovoid, light brown, shiny, smooth except for furrows along the distal face. (Fig 9, 49; Map 5).

Restricted to Western Australia where it is known from three localities in the northern part of the Avon and the western part of the Coolgardie Botanical Districts. Probably more widespread but overlooked because of its small size.

Unlike *Gunnioopsis septifraga*, which grows in extremely saline situations, *G. rubra* is known only to grow on light brown sandy loams and red loams under open *Eucalyptus* woodlands. At the type locality the species formed extensive patches in open areas between the mallee plants. It also occurred with *Calandrinia* and *Borya* on exposed granite, and on the margins of a wheat field.

Specimens examined

WESTERN AUSTRALIA: *G.J. Keighery 3318*, 60 km E of Mullewa, 29.viii.1980 (AD, KP); *K. Newbey 9328*, 5.3 km NNE of Yacke Yackine Dam, c. 75 km NNW of Bullfinch, 3.x.1981 (PERTH).

14. *Gunnioopsis propinqua* Chinnock, sp. nov.

Planta herbacea parva glabra; *foliis* linearibus; *perianthii segmentis* connatis, ovatis vel triangularibus, interne albis vel roseis; *staminibus* 4-12, fasciculis et 4 segmentis alternatibus; *capsula* ovoideo obtuso valvis profunde bifidis; *seminibus* ovoideis, aspectu distalibus triangularibus, colliculosis, cellularis 5-7 serialibus.

Type: *P.G. Wilson 7436*, von Truer Tableland, S of Lake Carnegie, Western Australia, 28.viii.1968 (holotype: PERTH; isotype: K).

Etymology: Latin *propinquus*, near: alluding to the similarity of this species to *G. septifraga*.

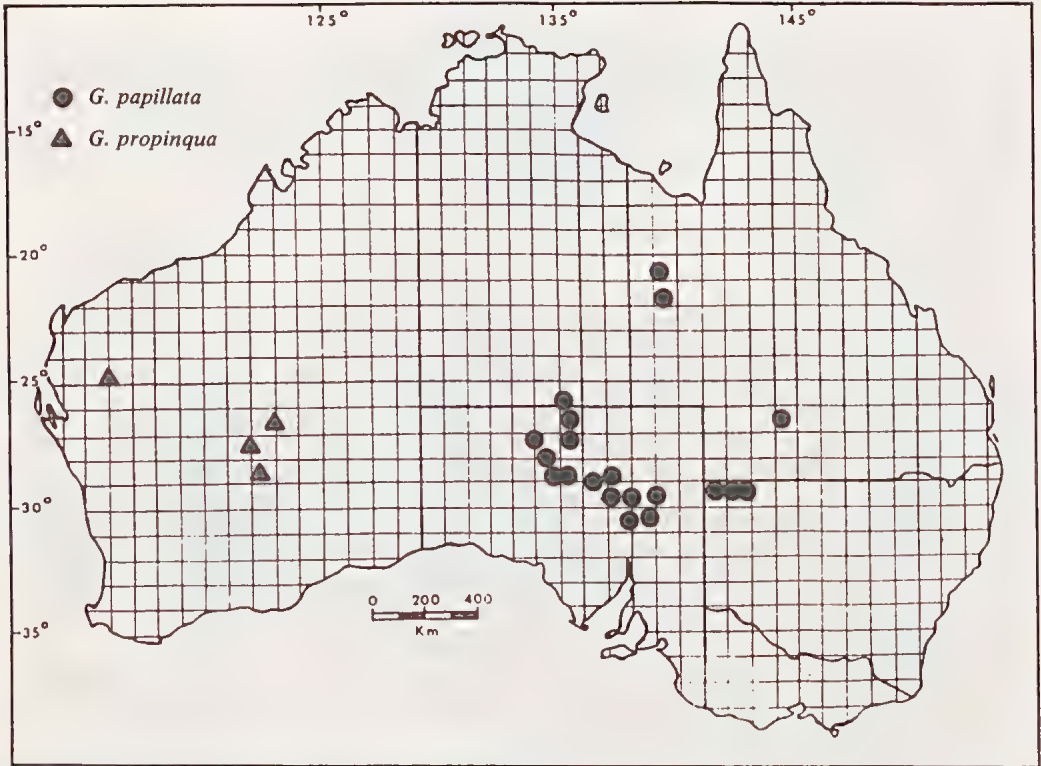
Herb 3-10 x 9-12 cm, prostrate, glabrous. *Branches* green turning stramineous when dry, smooth but often with scattered protruding salt pustules. *Leaves* green, linear, slightly channelled above, 8-12 (-24) x 1-2 mm, papillose, often with protruding salt pustules at least when dry. *Flowers* shortly pedicellate. *Perianth* fused basally; segments ovate to triangular, acuminate, 5-9.5 x 2.3-5 mm; outside surface green, inside surface white or pink. *Stamens* 4-12, in a single whorl, arranged in four bundles alternate with perianth segments, number in each bundle 1-3 and often unequal in same flower; filaments slightly flattened and dilating gradually towards base; anthers smooth. *Ovary* ovoid, shallowly 4-ribbed, smooth; stigmas smooth. *Capsule* ovoid, obtuse, ribbed to non-ribbed, 3 x 3-3.6 mm, membranous; valves when open deeply bifid. *Seeds* 0.4-0.7 x 0.35-0.5 mm, ovoid but \pm triangular in distal view, light to dark-brown, colliculate with cells arranged in 5-7 rows (distal view). (Figs 35, 50; Map 6).

G. propinqua is restricted to Western Australia and is known from a number of localities in the eastern part of the Austin Botanical District, and one locality in the extreme north-west of the Ashburton District.

This species grows in less saline situations than *G. septifraga* favouring lateritic outcrops or sandy stony loams.

Specimens examined

WESTERN AUSTRALIA: *W.E. Blackall 421*, near Laverton, E of Menzies, 10.viii.1931 (PERTH); *R.J. Chinnock 741*, 16 km S of 10 mile tank on Bandy-Banjiwarn road, 3.ix.1973 (AD); *P.G. Wilson 7285*, Mt Margaret, c. 32 km SW of Laverton, 26.viii.1968 (PERTH); *E. Wittwer 1041*, Mt James Station, 17.viii.1973 (PERTH).



Map 6. Distribution of *G. papillata* and *G. propinqua*.



Fig. 50. *Gunniopsis propinqua*. A, habit of plant; B, enlargement of branch with leaves and buds; C, leaf; D, open flower showing variation in stamen number (based on a number of flowers); E, open capsule; F, view of capsule and persistent filaments; G, I, distal views of seeds; H, lateral view of seed (A-C, E-H, *Wilson 7436*; D, F, *Chinnock 741*).

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References

- Adamson, R.S. (1959). The South African species of Aizoaceae. 7. Aizoon. *J.S. Afr. Bot.* 25: 29-50.
- Beard, J.S. (1965). "A descriptive Catalogue of West Australian Plants". (Society for Growing Australian Plants: Sydney).
- Beard, J.S. (1980). A new phytogeographic map of Western Australia. *West. Aust. Herb. Research Notes* 3: 37-58.
- Benthams, G. (1867). "Flora Australiense". Vol. 3. (Reeve: London).
- Black, J.M. (1924). "Flora of South Australia". 1st edn. Vol. 2. (Govt Printer: Adelaide).
- Black, J.M. (1948). "Flora of South Australia". 2nd edn. Vol. 2. (Govt Printer: Adelaide).
- Blackall, W.E. & Grieve, B.J. (1954). "How to know Western Australian Wildflowers". Part 1. (University of Western Australian Press: Nedlands).
- Burbidge, N.T. (1960). The phytogeography of the Australian Region. *Aust. J. Bot.* 8: 75-212.
- Diels, L. in Diels, L. & Pritzl, E. (1904). Fragmenta phytographae Australiae occidentalis. *Bot. Jahrb. Syst.* 35: 196-197.
- Dyer, R.A. (1975). "The Genera of Southern African Flowering Plants". Vol. 1. (Govt Printer: Pretoria).
- Erdtman, G. (1952). "Pollen Morphology and Plant Taxonomy". (Almqvist & Wiksell: Stockholm).
- Ewart, A.J. (1908). Contributions to the flora of Australia 7. *Proc. Roy. Soc. Vic. n.s.* 20, 2: 128-129.
- Friedrich, H.Ch. (1970). Aizoaceae. In Merxmüller H. (Ed.). "Prodromus einer Flora von Südwestafrika". (Cramer: Lehre).
- Gardner, C.A. (1930). "Enumeratio plantarum Australiae occidentalis". (Govt. Printer: Perth).
- Green, J.W. (1981). "Census of the Vascular Plants of Western Australia". (Western Australian Herbarium: South Perth).
- Jacobs, S.W.L. & Pickard, J. (1981). "Plants of New South Wales". (Govt Printer: Sydney).
- Linnaeus, C. (1753). "Species Plantarum". (Stockholm).
- Maiden, J.H. & Betche, E. (1916). "A Census of New South Wales Plants". (Govt Printer: Sydney).
- Mueller, F. (1859). "Report on the Plants collected during Mr Babbage's Expedition into the North West Interior of South Australia in 1858". (Govt Printer: Melbourne).
- Mueller, F. (1861). "Fragmenta Phytographiae Australiae". 2: 148-149. (Govt Printer: Melbourne).
- Mueller, F. (1871). "Fragmenta Phytographiae Australiae". 7: 129. (Govt Printer: Melbourne).
- Pax, F. (1895). "Aizoaceae". In Engler, A. & Prantl, K. (Ed.). "Die natürlichen Pflanzenfamilien". 1st edn 3, 1b: 33-51 (Engelmann: Leipzig).
- Pax, F. & Hoffman, K. (1934). "Aizoaceae". In Engler, A. & Prantl, K. (Ed.). "Die natürlichen Pflanzenfamilien". 2nd edn 16c: 179-233. (Engelmann: Leipzig).
- Stearn, W.T. (1973). "Botanical Latin". 2nd edn. (David & Charles: Newton Abbot).
- Toelken, H. (1981). "Aizoaceae". In Jessop, J. (Ed.). "Flora of Central Australia". 35-39. (Reed: Sydney).
- Troll, W. & Weberling, F. (1981). Infloreszenzstudien on Aizoaceen, Mesembryanthemaceen und Tetragoniaceen. (Steiner: Wiesbaden).
- Wagner, R. (1904). Ein neues Aizoon aus Südastralien. *Ann. Naturhist. Hofmus.* 29: 79-84.

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